If the status and quality of science education in schools is to improve, efforts need to be made to better understand the classroom practices of effective science teachers. Teachers are key players in a re-imagining of science education. This book explores how two primary school teachers, identified as effective practitioners, approached science teaching and learning over a unit of work. In recording the teaching and learning experiences in their classrooms, the author highlights how the two teachers adopted different approaches, drawing on their particular beliefs and knowledge, to support student learning in science in ways that were appropriate to their contexts as well as reflected their different experiences, strengths and backgrounds. Through sharing their stories, this book illustrates, that due to the complex nature of teaching and learning, there is no one way of defining effectiveness. In documenting this research, it is hoped that other teachers and teacher educators will be inspired to think about primary school science education in innovative ways.
Science in Primary Schools: Examining the Practices of Effective Teachers
Science in Primary Schools: Examining the Practices of Effective Teachers

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Numerous reports and research findings document problems and shortcomings associated with teaching and learning in science. It would appear that transmissive teaching practices, reliant on teacher lecturing and textbooks, remain commonplace in science classrooms across several countries (European Commission, 2007; Goodrum, Hackling, & Rennie, 2001; Millar, 1996). In keeping with the geographic location of the research reported in this book, the Government report *The Status and Quality of Teaching and Learning of Science in Australian Schools* (Goodrum et al., 2001) provided an informative and disappointing picture of the state of science education in Australia. In particular, the report uncovered the inadequacy of traditional teaching practices, for both primary and secondary schooling, in regards to developing students’ understandings of science and fostering positive dispositions towards science. In the report *Re-imagining Science Education*, Tytler (2007) describes science education as being trapped in a cycle of practice connected to its early roots; a reinforcing and recycling of the ways teachers themselves were taught science. It seems that the use of decontextualised and abstract knowledge, coupled with largely teacher-centred pedagogies, has reinforced a style of science teaching that supports and reflects many teachers’ identities as ‘knowledgeable experts’ (Tytler, 2007). This traditional approach may be comforting for teachers who have developed strategies for delivering such canonical-focused content, but it does little to boost the appeal and status of science in the minds of students.

Continuing low levels of student engagement in school science, and the downward trend in studying science beyond the compulsory years, strongly suggests that the traditional school science curriculum has become outmoded (Goodrum et al., 2001; Hassan & Treagust, 2003). While this creates a discouraging image, a move towards re-imagining what school science should encompass would assist in bringing about significant improvements in student learning and engagement (Tytler, 2007). However, for these improvements to become a reality, the powerful influence that teachers have on student learning would have to be acknowledged (Hattie, 2003). Teachers need to play a key role in bringing about this change.

The importance of strengthening and promoting science through quality science education should not be underestimated. Broadly, science education has a responsibility for developing the scientific literacy of all students (Goodrum et al., 2001). Scientific literacy enables individuals to actively make informed contributions to decision making processes regarding science-based issues at
public and on personal levels (Laugksch, 2000). To assist in building the capacity of individuals as scientifically literate citizens, confident and effective teachers of science are required (Goodrum et al., 2001; Hattie, 2003). Therefore, if the status and quality of science education in schools is to improve, efforts need to be made to better understand what constitutes effective science teaching practice.

This research was borne out of an attempt to address this need. The purpose of this study was to gather evidence about what effective science teaching looks like, in a primary school setting, over a sequence of lessons. New evidence was generated by this study, and is reported in this book, about effective science teaching practices in primary schools by focusing on what two effective primary school teachers were doing over a series of lessons to promote student understanding in and engagement with science.

The following research questions were considered throughout the study:

1. What characterises the practice of an effective teacher of primary science? and
2. Why is the observed teaching practice effective?

This book has been structured around five assertions, which were generated from this research about the influence of effective science teaching practice on primary school student learning in science. A model was developed (see Figure 1), which emerged from the analysis and interpretation of the data and identifies the interacting components that characterise the effective practice of the two teachers.

The components of this model can be explained and understood in the following ways. Effective practitioners use concrete experiences of science to provide their students with opportunities to explore science phenomena first-hand (Assertion 2), engage in meaningful talk about science (Assertion 3) and provide a context for the construction and use of multi-modal representational forms (Assertion 3). Teachers actively monitor these learning experiences and provide students with constructive feedback regarding their learning (Assertion 4). These components are embedded within inquiry-based approaches to science teaching and learning, which act to promote student interest and engagement (Assertion 1). Through nurturing student understandings and positive attitudes towards science (Assertion 1), effective primary science teachers support students in becoming scientifically literate citizens who are capable of engaging with science issues relevant to their lives and their communities (Assertion 5). Underpinning these practices are beliefs, knowledge and contextual factors, which directly impact on teachers’ orchestration of learning to meet their particular students’ needs in the contexts in which they work.
Prior to unpacking these assertions, Chapter 2 of this book describes the methodology used for this study, while Chapter 3 introduces the two participating teachers. The subsequent five chapters (4 to 8) are dedicated to making sense of each of these assertions by providing an overview of the contextual factors contributing to the teacher’s science teaching practices and report on the teaching and learning experiences of the teachers and their students. The final chapter presents the conclusions and discusses the implications of the research findings.
CHAPTER 2

METHODOLOGICAL APPROACH AND DESIGN

The methodological approach selected for this study was designed to reveal the classroom practices of effective primary science teachers. The use of an interpretive approach was an attempt “to understand and interpret the world in terms of its actors” (Cohen, Manion, & Morrison, 2007, p. 181), or in this particular case, to understand and interpret the teaching and learning of primary science drawing on the perspectives of teachers and their students. Through this chapter, the choices that were made regarding the methodological approach for this study, the research design, and the selection of research participants are described, as well, the data sources that were used and how the data were analysed. Due to the complexities inherent with educational research, this chapter also discusses the ethical considerations that were addressed and interwoven into the design of the study.

RESEARCH APPROACH

This study was qualitative in nature and incorporated ethnography with an interpretive case study approach (Merriam, 1998). This methodological approach essentially aims to understand the subjective and changing world of human experience. To make sense of this world, and the phenomena that are encountered, individuals construct their own realities and interpretations for this purpose (Usher, 1996). It is through conducting research that outsiders are able to access these personal understandings. The assessment of these understandings acknowledges in advance that there is a level of subjectivity inherent in the interpretation and in making meaning from the data.

Qualitative Research

Qualitative research is concerned with rich meaning and allows for the re-creation of a vicarious experience for the reader (Peshkin, 2000). A key assumption of qualitative research is that the meanings of events, occurrences, experiences and interactions can only be understood through the ways they are expressed by the participants (Gorman & Clayton, 1997). Therefore, the aim is not to support or reject the behaviour being studied, but to better understand the experience behind this behaviour. While this perspective focuses on better understanding peoples’ experiences and how they interpret their world, there is also an interest in simply acknowledging and understanding the experiences of others (Patton, 2002). In the context of this study, the qualitative approach has enabled the collection of stories
about primary science education, which in turn, has provided a realistic depiction
of the issues underpinning the human interactions occurring within the classroom.
This highlights the value of using qualitative research, which according to Merriam
(1998) is that, “researchers are interested in insight, discovery and interpretation
rather than hypothesis testing” (p. 10).

Broadly, qualitative research encompasses any form of investigation that
produces an outcome not reliant on statistical techniques and evaluations (Corbin
& Strauss, 2008; Patton, 2002). While not recent research, Eisner’s (1991)
identification of six characteristics typifying a qualitative study is still relevant.
These features are: the study is field focused and takes into account animate and
inanimate objects in a way that is non-manipulative and naturalistic; the self is an
instrument used in making sense of the situation; the study is interpretive in
character, aiming to uncover the social, political and cultural reasons for
behaviour; the study incorporates expressive language and the presence of voice;
there is attention to detail through an awareness of the aesthetic or contextual
features; and multiple forms of evidence are used.

The study of education is particularly suited to qualitative research as it involves
a community of people, engaged in the process of teaching and learning, who share
a particular cultural understanding made up of shared beliefs and attitudes.
Qualitative research is also able to capture the intricacies of and the complexities
inherent within the relationships occurring in the school setting. The task of the
researcher, according to Burns (1990), is to “capture what people say and do as a
product of how they interpret the complexity of their world, to understand events
from the viewpoints of the participants; it is the life world of the participants that
constitutes their investigative field” (p. 9). In studying such a culture, Wolcott
(1988) defines this type of qualitative research as ethnographic because it portrays
“literally, a picture of the ‘way of life’ of some identifiable group of people”
(p. 188). An ethnographer looks for the complexity and context of the study
(Cohen et al., 2007; Wolcott, 1994). Through my association with school culture, I
have my own store of experiences that may be drawn upon when observing,
discussing and reflecting upon this ‘way of life’ in terms of teaching and learning
science in the classroom (Mulholland, 2007).

Through the use of a qualitative methodology, this study intends to develop an
understanding of how the practices of effective primary school teachers support
teaching and learning in science in the classroom.

*Ethnographic Research*

Ethnography is a qualitative method used by researchers to study human behaviour,
and importantly, to access the meanings that guide this behaviour (Hammersley &
Atkinson, 2007). Ethnographers can represent and interpret the experiences of their
participants through the use of naturalistic strategies (e.g., participant observation) and
fieldwork (Creswell, 1998; Gobo, 2008). In an educational context, ethnography
provides a way of gathering and interpreting rich, descriptive data about the activities
and beliefs of teachers and students (LeCompte & Preissle, 1993).
Traditionally, ethnographic research has focused on developing a written representation of a culture, or aspects of a culture, as the result of extensive fieldwork (Berg, 2001; van Maanen, 1988). However, ethnographic field strategies are no longer restricted to the work of anthropologists, with new ethnographers being described as anyone who enters a natural setting to conduct field research (Berg, 2001). New ethnographers also have access to the latest technologies, which in this case, allows for teachers’ practice to be captured, represented and analysed. Ethnographic research often draws on multi-modal techniques in the collection of data. In recent times, this approach has seen the introduction of digital technology, such as video, as a way of capturing human interactions (Shrum, Duque & Brown, 2005). While there is essentially nothing new about the incorporation of the visual into ethnography (e.g., photos, sketches, paintings, film), there has been a tendency for researchers to focus on using words to describe their observations (Pole & Morrison, 2003). However, video-based data, in particular, has a rich and visually appealing nature that conveys a strong sense of direct experience (Schuck & Kearney, 2006). Consequently, there has been a shift towards video as a new way of presenting and practising field research, which has seen video ethnography expand (Shrum et al., 2005).

In the broadest sense, video ethnography refers to “any video footage that is of ethnographic interest or is used to represent ethnographic knowledge” (Pink, 2007, p. 169). However, it is important to acknowledge that the interpretation of video footage is never value free (Pink, 2007). Therefore, reality does not exist as observable facts captured on video. Real understanding needs to be developed through conversation and negotiation between participants and researcher.

Video ethnography has the capacity to capture classroom activity and enables detailed examination of teaching and learning from multiple perspectives (Hollingsworth, 2005). This can stimulate discussion between teachers, students and researchers, generating deeper understandings of teaching practice. Video ethnography also creates a new dimension for describing and interpreting teaching and learning. However, there are implications for educational researchers. In adopting this approach, researchers will need to develop new technological and cognitive skills for dealing with the planning, capture and analysis of video. Researchers will also need to negotiate more complex research protocols that include copyright issues and human participant considerations, such as access to schools and the identification of students.

The ethnographic characteristics of this study will be particularly evident within the interactions that occur between me as the ‘observer’ and the participating teachers and their students as the ‘observed’ (Berg, 2001). However, it would be preferable to think of these relationships as being one built more on shared contributions. This research relies on the development of a partnership between the participating teachers and me, with the product of this interaction being an in-depth understanding of the actual practices behind their effective science teaching.
Case Study Research

Case studies are capable of capturing an experience through in-depth explorations and analyses of particular people, social settings, events or groups (Berg, 2001). These features make it a particularly appropriate research design for the study of education as it helps to portray a detailed picture of the complexities inherent in the classroom interactions between teacher and students and in the work of teachers (e.g., Mulholland & Wallace, 2003). Doyle (1990) suggested that “teachers’ knowledge is ‘event structured’ therefore teachers’ knowledge is fundamentally particularistic and situational. Their knowledge is, in other words, case knowledge” (p. 356). Conducting this research as an ethnographic case study acknowledges that this approach provides the most appropriate means for documenting the sociocultural analysis of specific issues and themes that arise from recording classroom practices.

The ethnographic case study is further defined through an interpretive perspective, which allows for rich, ‘thick’ descriptions of the experience that help to develop grounded theory (Guha & Lincoln, 1989; Merriam, 1998). Merriam (1998) states that while a case study will be descriptive and inductive; it will focus on a particular aspect of a phenomenon. As the specific experience unfolds, the researcher may use multiple sources of information and evidence to create a multi-layered representation of the case (Bell, 2002; Creswell, 1998). Case study research allows the researcher to gain an understanding of the situation, and meaning, from those involved (Merriam, 1998; Yin, 2009).

This form of research is positioned within real-life contexts and within a bounded system, which refers to the specific case being bound by the time and place in which it occurs (Creswell, 1998; Yin, 2009). Therefore, case studies allow researchers to concentrate on capturing specific instances or situations at specific moments in time within specific locations. While there may be concerns about what can be learnt from such contextually bound research, the answers lie in the deeper knowledge and understanding gained through this process of inquiry and from the product of that inquiry (Stake, 2000). It is only by observing the practice of teachers in the context of specific learning tasks, and student learning behaviours, that the relationships between teaching and learning can be understood. The nature of this approach is to capture, in great depth and detail, an experience that is occurring within a wider context.

For this research, a case study approach was preferred as a way of capturing and communicating the rich detail of the classroom experiences of two effective primary science teachers. It is acknowledged that contextual and environmental factors will potentially shape and influence the images that will be constructed of effective practice. Influences such as the characteristics of the student group (e.g., backgrounds and ages), the science curriculum content being taught and the participating teachers’ preferred teaching styles are factors providing the background context for these two unique cases.
METHODOLOGY

RESEARCH DESIGN

The research design chosen for any particular study can be considered as linking the data that is to be collected with the initial questions shaping the study (Yin, 2009). Figure 2 provides an overview of the research design used for this study by outlining the participants and data gathering techniques used during Phases 1 and 2 of the data collection process. The following section describes this process.

Participants in the Study

For case study research, the selection of an appropriate ‘case’ is an important process. The determination of, in this instance, who will be studied provides the case study with specific boundaries (Stake, 2000). This study was conducted in two phases with a different configuration of participants involved in each phase. This section will identify how teachers were chosen to participate in this study as effective practitioners of primary science and outline the participants involved in each phase.

Peer nomination. The opinions of colleagues and educational bodies have been used in other studies as a means of identifying effective teachers (e.g., Ayres, Sawyer, & Dinham, 2004; Tytler, Waldrip, & Griffiths, 2002). This way of identifying effective teachers usually occurs through nomination by peers, teacher educators, government curriculum advisors or on the basis of receiving awards and public recognition. Using peer nomination is similar in nature to using a purposive sampling technique, as information about the teachers is used to help with the selection of appropriate participants (Berg, 2001; Creswell, 1998). A potential weakness of this method is that the nomination of effective practitioners is subjective as public, professional attributes do not necessarily equate with classroom expertise.

For this study, a professional colleague, working with primary school teachers across the Australian state of Western Australia in the area of primary science, was approached and asked to nominate some teachers she thought to be effective practitioners of science. This query led to the identification of four teachers from four different schools located across the main metropolitan region of this state. Through the professional colleague, the four teachers were invited to attend an after-school meeting that was aimed at informing them about this study, discussing their potential role in the study and gauging their interest in being involved. This meeting took place over an hour, during which all aspects of the research were outlined to the teachers and they were given the opportunity to ask any questions or raise any concerns. At the end of this meeting, the teachers were provided with an information letter outlining Phase 1 and were asked to make contact if any queries arose. The teachers were given some time to process this information and talk with their principals about their potential involvement in Phase 1 of the study. Three weeks later, I contacted the teachers to gauge their interest and to address any remaining questions they might have. All four teachers expressed interest in being
involved in the initial stage of this study. At this time, a letter explaining Phase 1 was sent to their principal and each teacher was provided with a class set of information letters and consent forms for their students. A time was arranged to meet with each teacher and their principal, where the study was discussed further and possible times to visit their classrooms, during a science lesson, and conduct an interview were arranged.

![Diagram](image)

*Figure 2. Overview of research design used for this study.*

**Phase 1 participants.** The teachers involved in Phase 1 of this study (Term 4, 2007) were Rebecca, Kate, Lisa and Deanne (pseudonyms). During this time, each teacher was working with students from different year levels. Rebecca was working with Year 1 and 2 students (27 students aged four to six years), Lisa with
Year 3 and 4 students (26 students aged seven to nine years), Kate with Year 4 students (32 students aged eight to nine years) and Deanne with Year 6 and 7 students (26 students aged 10 to 12 years). In Western Australia, Year 7 is the final year of primary school education.

**Phase 2 participants.** Phase 2 of this study would require a high level of commitment and involvement from the teachers. These teachers would be opening up their classrooms to be observed and video-recorded, as well as being asked to devote time to discussing and reflecting upon their practice. While this process would be time consuming and confronting, it was hoped that it would also provide an enriched professional learning experience for the participants. Each teacher needed to consider if they were willing and able to dedicate the time and commitment required for this research. Subsequently, two of the teachers withdrew, whilst Deanne and Lisa indicated that they would like to continue with the research. The selection of the Phase 2 participants essentially came down to personal decisions made by the individual teachers.

Phase 2 of this study (Term 2, 2008) was conducted with Lisa’s class of Year 3 and 4 students (26 students, aged seven to nine years) and Deanne’s class of Year 7 students (21 students, aged 11 to 12 years). The data were collected over one term (10 weeks) with nine data collection sessions in Lisa’s classroom and 10 data collection sessions in Deanne’s classroom. The parents of both groups of students were informed of this next phase of the study and written permission was sought from parents and students. Several informal, familiarisation visits were made to each class during science lessons in the term leading up to the Phase 2 data collection.

To complement the data gathered from the teachers participating in this part of the study and to gain a perspective of effective science teaching from the ‘consumers of education’, focus groups of students were formed. These students were a volunteer sample based on teacher suggestions of students who would work well together and be willing to communicate their ideas to me. There were four students from each class (two females and two males) who gave their consent and had the consent of their parents to be involved in this study. The focus group students from Deanne’s class were Anna, Evan, Natalie and Mark and the focus group students from Lisa’s class were David, Ella, Georgia and Michael (all pseudonyms).

**Phase 1 Data Collection**

The first phase of the study was conducted to validate the teachers’ nomination as effective practitioners of science. Phase 1 of the data collection employed three methods: interviews; classroom observations; and a questionnaire measuring student attitudes towards and interest in science.

**Interviews.** While interviews are not necessarily recognised as a method for identifying effective teachers, they are a source of data appropriate for an interpretive research approach. The purpose of conducting interviews in Phase 1 was to assist in developing an understanding of the beliefs and knowledge held by each of the teachers’ regarding science teaching and learning. With this purpose in
mind, it seemed that a semi-structured interview format was a more practical and functional way of collecting data for this phase of study (Brown & Dowling, 1998).

A convenient time was arranged with each teacher to be involved in a semi-structured interview. The interviews with Deanne and Rebecca were 10 minutes in length, while the interviews with Kate and Lisa were 15 and 20 minutes in length, respectively. For Deanne, Lisa and Rebecca, the interviews took place within a week of a second visit to their classrooms. Kate’s interview took place between the first and second classroom visits. The interviews were conducted in the staffroom at each of participating teachers’ schools. Figure 3 outlines the questions that were used to guide the initial semi-structured interviews.

1. What do you think about when you plan science lessons?
2. What do you hope your students will achieve from your science lessons?
3. Describe one of your science lessons that went really well. In what ways was this lesson a success? Why did it go really well?
4. What do you consider to be characteristics of effective science teaching?

Each interview was recorded using a digital recorder and transcribed. The data collected through this process were subsequently used in conjunction with classroom observations and student questionnaires to identify the emergent themes characterising the initial beliefs of the four teachers.

Classroom observations. Classroom observation is another method that can be used in identifying effective teachers (e.g., Ayres et al., 2004; Berliner, 1986). Lesson observations are typically recorded over a few hours of classroom time with observers recording information about the teacher and students in the class, such as strategies used and teacher-student interactions. Some observers may be advised to look out for particular events or behaviours as determined by previous research findings (Borko & Livingston, 1989; Louden, Rohl, Barratt-Pugh, Cairney, Elderfield, House, Meiers, Rivalland, & Rowe, 2005). Others may have the freedom of allowing the teachers’ interpretations to guide the nature of their study, which avoids the imposition of existing preconceptions (Brown & McIntyre, 1993; Cooper & McIntyre, 1996). The use of observation allows researchers to experience the classroom environment and the activities occurring within that context first-hand. During observations, observers often take notes or records that can be utilised in follow-up interviews with teachers as a point of reference for discussion or analysis (Cooper & McIntyre, 1996; Tobin & Fraser, 1990). This shared experience in the classroom can provide a useful focal point for an interview.
METHODOLOGY

However, observational approaches are often limited by their short-term nature. Classroom observations can effectively provide a snapshot of what is occurring during a particular time in a particular context, but may not be representative of what usually occurs in the class (Gray, 1999). It is possible that certain features of a lesson may be recorded, particularly when structured observational formats are being used, to the omission of other important information (Bell, 2002). Another limiting factor may be the presence of an observer, which could result in a less-than-accurate representation of the usual classroom situation (Gray, 1999).

Classroom observations were used to assist in the identification of effective primary science teachers for this study as it allowed first-hand experience of what was actually happening in the classrooms of the four teachers. The observations provided the opportunity to draw comparisons between the teacher’s beliefs revealed in the interview and their actual practices. Each classroom was visited twice over a period of four weeks during the Phase 1 data collection (Term 4, 2007) and comprehensive field notes were taken.

Questionnaires. Student questionnaires and other measures of students’ attitudes towards and interest in science have been used across numerous studies as a means of identifying effective teachers (e.g., Brown & McIntyre, 1993; Evans, 2002). Focusing on the perspectives of students has a unique value, because students have knowledge of how lessons are conducted on a daily basis (Brown & McIntyre, 1993). Students bring a wealth of comparative information, on which to base their decisions about a teacher’s practice, due to their experiences with a variety of teachers, classroom strategies and teaching styles over their years of schooling (Murphy, Delli, & Edwards, 2004). But subjective biases or preconceived notions of what constitutes an effective teacher may blur students’ judgements. Influencing factors, such as teachers’ reputations or personalities (Borko & Livingston, 1989), can result in inconsistent results appearing within the student population as well as between students and other evaluators.

To gather an alternative view of the four teachers’ practices, the students in their classes were given an anonymous questionnaire to complete. This questionnaire was adapted from the Primary School Science Questionnaire used as part of the research conducted by Goodrum and his colleagues’ (2001) for their report, The Status and Quality of the Teaching and Learning of Science in Australian Schools. This questionnaire assessed the students’ attitudes towards and interest in science. The data from this questionnaire helped to show the extent to which the teachers engaged their students in science and developed interest in science.

Phase 2 Data Collection

The use of multiple data sources in case study research will, according to Cohen and his colleagues (2007), “attempt to map out, or explain more fully, the richness and complexity of human behaviour by studying it from more than one standpoint” (p. 269). Essentially, using extensive, multiple sources to collect data allows for a detailed, in-depth picture to emerge from the research findings (Creswell, 1998; Yin, 2009). The collection of information using multiple sources also opens up the
possibility of triangulation, which can be used to ensure the credibility and confirmability of the data (Corbin & Strauss, 2008; Lincoln & Guba, 1985). For Phase 2 of this study, data were collected through several sources: video footage; interviews with the teachers and small groups of their students; and artefacts from the classrooms.

*Video footage.* The use of visual methods in research, such as video cameras, was once limited. Though, as we evolve as a technology-driven society, they are no longer cost prohibitive, technologically complex pieces of equipment that can only be used by trained professionals. Relatively recent improvements in this technology have turned video into a user-friendly medium, which enables the capture of rich and detailed data (Hollingsworth, 2005). At a basic level, video data can be captured by setting up a camera and recording what occurs. But in moving from the basic level, there are numerous choices that need to be made each time videoing is planned. The procedures used and choices made regarding the use of video in this study are discussed below.

It is not possible to gather an exhaustive account of any one context, regardless of the data collection tools used. Therefore, sampling decisions need to be made (Erickson, 1992). The use of video requires decisions, such as where cameras will be placed (e.g., hidden or conspicuous) and the choice of frame angle (e.g., wide frame or close up) (Ratcliff, 2003). Researchers need to be aware that sampling decisions connected with capturing research footage differ to commercial footage. Simplicity is the key to capturing research video as this process requires footage that has visual framing which is consistent across time, produces a clear image and has clear sound (Gobo, 2008). It is important to remember that any video record is an incomplete document of what actually happened, even when shot continuously. A video camera is limited in what it can capture, when it is captured and from what perspective (Ratcliff, 2003).

Many of the sampling decisions connected with this study remained constant, such as what would be captured (i.e., every science lesson over a term) and when it would be captured (i.e., where the lesson fitted within the weekly teaching program). Other decisions were negotiated based on the classroom environment, such as the placement of the cameras and the degree of zooming. Three video cameras, mounted on tripods, were set-up in each classroom to capture the teacher’s practice and their students’ actions during science lessons. The cameras were positioned in the following way: one camera in the back of the room which followed the teachers’ movements; one stationary camera with a wide-angle lens at the front of the room, which focused back on the entire student group; and one camera, which focused on the actions of the focus group students. A research assistant operated the teacher camera and the researcher operated the student camera. The configuration of the cameras in both classrooms remained as consistent as possible. Due to the nature of the unit, both Lisa and her students moved frequently in and out of the classroom, which required the cameras to move with them.

FM microphones were used to record the verbal communications of the teachers and the focus group students over the whole sequence of lessons. The teachers wore a lapel microphone, which was connected to a transmitter. Their communications were
transmitted to a receiver, which was attached to the teacher camera and allowed for their verbal communications to be recorded ‘in synch’ with their actions. The transmitter for the focus group students was positioned inside a pencil case and located in the centre of their work space with the microphone attached to the outside of the pencil case. When the students in Lisa’s class moved outside, the microphone was removed from the pencil case and attached to the lapel of one of the students. The focus group students’ communications were transmitted to a receiver, which was attached to the student camera and recorded ‘in synch’ with their actions. Sound levels were monitored throughout the lessons to ensure clear and audible sound was collected from the teachers and the students.

The video cameras that were used for this research were Sony HVR-V1 models, which allowed for high-quality footage to be captured. Each lesson was taped onto 60-minute mini-DV tape (usually two tapes per camera per lesson were used) and later converted into a digital format (in this case, QuickTime files).

Video can capture and present teaching and learning as it occurs. Concerns regarding the intrusive nature of video cameras and their potential impact on behaviour challenge the authenticity of video data (Schuck & Kearney, 2006). Research has identified that while participants find the presence of a video camera intrusive during the first video recording sessions, their awareness of the camera subsides over time (Gobo, 2008). This awareness may be evident in the reactive effects displayed by participants, such as acting for the camera (Ratcliff, 2003). However, as the camera becomes part of the environment, this reactivity tends to become less pronounced. The participating teachers were nervous and confronted about being filmed, which was evident in early lessons. However, while they claimed to be continually aware of the cameras presence, their anxieties obviously dissipated as they became more comfortable with the research process. The students were excited about being filmed and reacted to the presence of cameras by waving to or hovering near the cameras. These acts of recognition became less frequent as the research progressed. In anticipation of these forms of reactivity, I regularly visited the classrooms prior to the Phase 2 data collection (Term 2, 2008). To reduce the intrusiveness of the video cameras, I set them up in the classrooms during a lesson towards the end of Term 1 and provided the students and teachers with the opportunity to view footage of the class and interact with the cameras. This process seemed to reduce the intrigue surrounding the cameras and assisted in building relationships with the teachers and their students.

The use of video research to capture what was occurring within Deanne and Lisa’s classrooms was essentially an extension of the traditional observational approaches used for collecting qualitative data. The use of video recording as one of the data sources for this study enabled information about classroom activities to not only be gathered from multiple vantage points, but to be viewed multiple times and illustrative points transcribed. Through using video technology, it was possible to gather detailed descriptions of many aspects of effective science teaching over the term. Additional data sources, such as field notes and interviews with teachers and students, were crucial in helping to contextualise what was captured on video.
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Interviews with teachers. Interviews were used to explore Deanne and Lisa’s thinking about their objectives for a lesson and the strategies they used with their class, as well as to better understand their thoughts about effective science teaching and learning. The aim of these fairly informal interviews was to establish why they used particular practices in particular situations. These discussions were guided by the events and experiences that occurred in the previous lesson or over a number of lessons. Therefore, the use of a semi-structured format was a practical and functional way of collecting data for this phase of the study (Brown & Dowling, 1998). To assist with this process, segments of the video footage collected from the classroom were replayed to Deanne and Lisa during some of their interviews to help guide and focus the dialogue when analysing and making sense of what occurred in the classroom (Ratcliff, 2003).

These teacher interviews usually took place two days after their science lessons. Deanne was involved in 10 interviews of approximately 30 minutes in length, whereas Lisa, due to a shorter unit and a busy schedule, was involved in seven interviews of approximately 45 minutes in length. Deanne’s interviews took place in the staffroom at her school and Lisa’s interviews took place in a room situated at the University. Each interview was recorded using a digital recorder and transcribed. Figure 4 outlines some of the broad questions that were raised, in these semi-structured interviews, with Deanne and Lisa over the duration of the study.

| 1. What did you think about as you planned for this lesson? Why? |
| 2. What factors influenced your lesson planning? Why? |
| 3. What expectations did you have for the students? Why? |
| 4. What events/episodes in the lesson were particularly important for student learning? Why? |
| 5. If the video cameras weren’t in the classroom, would you have conducted this lesson any differently? |

Figure 4. Teacher interview questions (Phase 2).

Interviews with focus group students. The focus groups students were also interviewed to identify and discuss the parts of the lessons that helped their science learning. The focus group students from Deanne’s class were interviewed directly following each science lesson. These students were interviewed 10 times with each interview taking approximately five minutes. In Lisa’s class, it was more convenient to interview the students the week following a science lesson, in the 15-minute block of silent reading that preceded their science lesson. These students were interviewed eight times with each interview taking approximately five minutes.
Interviewing the students as a group created a more relaxed environment and helped the students to feel more comfortable about voicing their ideas and thoughts. The interviewing of the students in small groups rather than individually also helped to stimulate discussion about the science lessons as the students were able to bounce ideas off each other. The focus group interviews also used a semi-structured format to provide the students with some guidance throughout the discussions (Brown & Dowling, 1998). Figure 5 outlines some of the broad questions that were raised with the students in the focus group sessions.

| 1. | What did you learn today? |
| 2. | Did you enjoy the science lesson today? Why/why not? |
| 3. | What do you think your teacher wanted you to learn? |
| 4. | What things helped you to learn in science today? |

Figure 5. Student focus group interview questions.

Artefacts from the classroom. Written documents were collected continuously from Deanne, Lisa and their students as a source of data. Documents, such as unit plans, worksheets, assessment items and work samples, were photocopied by the teachers and provided to me. Lisa also provided hard copies of the work that her class developed using the interactive whiteboard and a list of her online resources.

DATA ANALYSIS

The analysis for this study consisted of building two case studies illustrating the effective primary science teaching practices of the participating teachers, Deanne and Lisa, and the learning behaviours and outcomes of their students. Data from the following sources were analysed: video footage; transcripts of the interviews with the teachers; interviews with the focus group students; and artefacts collected from the classroom. The triangulation of the multiple data sources used in this research helps to ensure the credibility, transferability, dependability, confirmability and authenticity of the data (Lincoln & Guba, 1985).

The data were examined to identify patterns in Deanne and Lisa’s science teaching practices. Specifically, the focus was to identify data that shed light on the learning experiences and teaching strategies used, why they were used, and how they relate to their enacted practices. While components identified within the literature assisted with this process, this study used an inductive approach to the data analysis, which enabled a more receptive approach to unexpected patterns or themes. This was an important consideration as case studies provide the reader with a rich, multi-dimensional picture illustrating the relationships, issues, and patterns occurring within the two classrooms (Bell, 2002). If the study remained confined within a prescribed framework, the representation would perhaps
resemble a flat, two-dimensional image; not revealing the full story. This inductive approach enabled these constructs to emerge out of the data rather than imposing them on the data prior to collection and analysis (Patton, 2002). The focus on emergent interpretations, rather than on existing theories, is a legitimate approach to data analysis that is based in grounded theoretical understandings of research (Corbin & Strauss, 2008).

Analysis is required to make information meaningful. The use of video footage, as opposed to just direct observations and field notes, allows for a more detailed analysis to occur (Gobo, 2008). The analysis of video records does not have to wait for instances of a particular event to occur as there is the ability to revisit a particular set of instances by replaying the footage (Erickson, 1992). This ability to revisit the same event for repeated observation is the main advantage of video research. Video footage provides researchers with multiple ways of analysing and interpreting teaching and learning events. This research tool opens up a way of attending to the layers of complexity that are inherent in teaching, such as content, context and pedagogy.

Erickson (1992) outlined a five-step process for analysing video footage, known as ethnographic microanalysis. Linked with analytic induction, this approach emphasises that an event or behaviour can be described, measured or tracked in detail through repeated examination of video sequences (Ratcliff, 2003). This process can be summarised as watching a video sequence in its entirety, identifying major events within the sequence, looking at the links between event segments, transcribing the interactions, and comparing segments across the video data set (Erickson, 1992). This layered approach to analysis not only examines the detail in ‘strips of activity’, but also provides a more holistic perspective by positioning what is occurring within the broader context. Ethnographic microanalysis has the capacity for a completeness of analysis through multiple viewings for different purposes.

For this study, Erickson’s ethnographic microanalysis was used to analyse the data. Initially, I was immersed in watching the complete sequence of video footage captured from one classroom. Different aspects of the footage, such as instructional settings, construction of the scientific story and management of the teaching and learning approaches, were then examined. For example, in scrutinising how the scientific story emerged, the concepts and processes that were taught over the unit were reviewed in terms of how they were linked within and between lessons. To make sense of each sequence, I wrote descriptions, transcribed interactions and created visual representations of the data. In this sense, the analysis of the video footage involved two distinct processes; watching the video footage and writing about the video footage.

Merriam (1998) suggests that through being responsive to the context of the study, researchers can adapt their analysis techniques to better suit the situation through clarifying and summarising their study as it evolves. This inevitably raises issues about the positioning, neutrality and objectivity of the research process and more specifically of the data analysis. No one person is value free. Interpretations and understandings of data are passed through a filter, which, in this case, was my frame of reference (Carpenter, 1999). Given my positioning within this research,
my own experiences as a science teacher and the close working relationship that I formed with the participants, it was important to be aware of the possible impact of my personal values and preconceptions on the data collection and interpretation of the data.

A basic goal of analysis in ethnographic studies is to create vivid reconstructions of the settings studied (LeCompte & Preissle, 1993). However, the ways in which researchers describe what they observe may be quite different from the meanings that participants use to construct their own experiences. As an analytical tool, video can assist the researcher, but the process of video analysis is a complex task. Developing an understanding of what is occurring in a setting should be a co-operative effort between the researcher and the participant (Ratcliff, 2003). By viewing video footage together, the researcher can discover what meanings participants attribute to different activities and contexts, and how they interpret what is portrayed (Pink, 2007; Ratcliff, 2003).

In interpreting events captured on video, I worked with the teachers in two ways. Firstly, through the data collection process, I conducted interviews with the teachers, so that they could discuss why they taught a lesson in the ways that they did. As part of these discussions, we watched segments of the lesson and the teacher would give her interpretation of what was happening. These episodes were short (e.g., no longer than five minutes at a time) and were selected by me. Video segments were chosen to enable the teachers to reflect on the strategies and approaches they used when teaching science. In hindsight, watching longer episodes would have been preferable. Secondly, when the emergent themes that characterised teaching practice were identified, I contacted the teachers by e-mail to establish if my interpretations were congruent with their interpretations. While it would have been ideal to regularly meet with the teachers as the analytical process continued, I did not want to further intrude on their time.

Due to the complexity of each case study, analysis can be very difficult (Blaxter, Hughes & Tight, 2002). The holistic nature of this approach identifies the connections that exist between the innumerable events and outcomes, which create a sense that everything is relevant. Ultimately, the cases emerged through this process to illustrate the beliefs, knowledge and practices of Deanne and Lisa; two primary teachers identified as being effective science practitioners.

ETHICAL CONSIDERATIONS

Phase 1 of this study involved four primary school teachers and their students. After the initial contact meeting, letters explaining Phase 1 of this study were sent to the four teachers and their principals to outline the study and to establish agreement to become part of the study. Letters were then sent to the parents of all four classes to inform them of the purpose of the study and to ask their permission for their child to be involved in the study. The students involved were also asked to give their consent to participate in this study. For Phase 1, permission was sought from each principal, teacher, parent or guardian and student to observe two science lessons, interview the teachers and have a questionnaire completed by the students.
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This process was repeated for Phase 2 of this study, with letters sent to the two teachers and their principals, to outline this next stage of this research and to again establish agreement to continue their involvement in this study. Letters were again sent to the parents of the two classes to inform them of the purpose of the study and to request their permission and their child’s permission to be involved in the study. Four students from each class also received letters asking for permission to be involved in the focus group discussion. For Phase 2, permission was sought from each principal, teacher, parent or guardian and student to observe and videotape the science lessons, interview the teachers and the focus group students following each science lesson, and to collect classroom artefacts, such as student work samples.

The nature of this research design required mutual respect, the development of productive relationships, and the establishment of a cooperative environment between the participating teachers, their students and me. Initial interviews with the teachers outlined the extent to which my presence would impact upon their science lessons. The teachers were made aware of my experience as a practising classroom science teacher, which highlighted that I had an understanding of the work of teachers and empathy for how busy they were. At all times during the study I was careful to accommodate changes to the scheduling of the lessons and the requirements of the teachers.

Specific details regarding the ethical considerations of anonymity, informed consent and withdrawal rights are outlined below. In light of the use of video as a data collection tool in Phase 2 of this study, consideration was also given to the appropriate use of the video data that was collected.

Anonymity

The nature of using video recording to capture the events occurring within the classrooms of the participating teachers raises issues regarding the lack of anonymity for the participants involved in this study. The participants were informed through a written information letter of how the data would be collected and analysed, as well as of the potential uses of the video footage captured. However, additional consideration was given to how the footage would be presented in digital form and subsequently reported within the research report to ensure that the participants’ identities were protected.

Many of the challenges inherent in collecting video data are connected with ethical considerations. Anonymity, in particular, seems to be the most salient (Erickson, 1992). One of the stumbling blocks for participants in video research is the fear of potential embarrassment (Schuck & Kearney, 2006). While the faces of participants can be masked through editing, behaviours and actions are preserved. Researchers need to develop protocols for preventing harm, particularly in the form of embarrassing events, being captured on video (Erickson, 1992). In this study, this concern was minimised through emphasis of the participants’ right to view and/or have erased any footage they feel uncomfortable about. Other concerns connected with anonymity, such as dissemination of footage, were also considered (Schuck & Kearney, 2006).
The participating teachers were given editorial control over any products created from the video footage to ensure that they and their students would not feel uncomfortable about any aspects of the footage. Therefore, the teachers would be consulted and need to provide their consent for any of the captured video footage to be created into edited packages of footage. Consent was given by the teachers, students and parents for this footage to only be used for the professional learning of preservice and inservice teachers. Any packages of footage created would be presented in a positive light and would solely focus on effective science teaching practices.

This study planned to distance the written report from any edited footage to ensure that if the participants were identified through the video imagery that they were recognised for their effective practice and could not be linked to any of the written interpretations of these practices. Therefore, my name would not be connected to any of the final video packages and while the participants’ real names may be referred to in the footage, pseudonyms have been used to refer to the participating teachers, students and schools throughout this book. The aim was for the participants’ identities to remain anonymous through any reporting (e.g., conference presentations, journal articles) connected with this study.

**Informed Consent**

Primary-aged students participated in Phase 1 and 2 of this study, which required informed consent from the student and from their parent or guardian. For Phase 1, the students completed an anonymous questionnaire measuring their attitudes and interest towards science. An information letter was sent to parents or guardians to inform them of this activity and to seek their consent. If they did not want their child to complete a questionnaire, their classroom teachers did not involve them in this activity. For Phase 2, all of the students had the potential to be captured in the general video footage taken of the class. A focus group of students (four students from each class) were also formed in each class and filmed extensively as part of the study. All students and their parents or guardians were required to provide written consent for their involvement in the research generally and/or as part of the focus group. It was acknowledged that there were students whose parents or guardians did not wish for them to participate in this study. In this case, an area of the classroom was designated a ‘no-go video zone’, so that students could still participate in their science class without being captured on film. There was one student from each class who could not be captured on film, and with assistance from the teachers, the zones worked appropriately.

**Withdrawal Rights**

The participating teachers and students were informed that they were able to withdraw from the study at any time. While the questionnaire material collected from students in Phase 1 of the study was anonymous, if any individuals wished to withdraw from the study any interview data collected during either Phase 1 or 2 would be erased and any video footage that was captured during Phase 2 depicting
them would be excised. Also, if the participating teachers chose to withdraw from either Phase 1 or Phase 2 of the research, they needed to specify whether their withdrawal meant: that while no new data would be collected from them, any existing video footage or interview data could still be used; or that they would like to completely withdraw any data involving or depicting them from the study. Two of the original four teachers involved in Phase 1 of the study decided to not continue into Phase 2, though gave consent for the collected data relating to them to still be utilised.