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Formative Assessment in Science Classrooms

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By
Bronwen Margaret Cowie

University of Waikato

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Abstract

This study investigated how formative assessment was perceived, experienced and accomplished by teachers and students in ten Year 7 to 10 science classrooms. The study was undertaken within and built on the findings of the Learning in Science Project (Assessment). An interpretive methodology using interviews and participant observation was employed. The study consisted of two phases. During the first phase, the teachers and at least three students of each teacher were interviewed and three classroom observations undertaken to ascertain views of formative assessment. In phase 2, case studies were developed of the formative assessment in the different classrooms. In addition, the teachers participated in eleven teacher development days, which were audio-taped and analysed.

While the literature provided a definition and discussion of formative assessment relatively little research had explored student perceptions and experiences of formative assessment as an aspect of their everyday classroom life. The links between formative assessment and views of learning had received very little attention. The study provides empirical evidence that formative assessment is accomplished through situated teacher and student actions and interactions that involve the exchange, interpretation and action on information about student learning. It seems teachers and students are active and intentional participants in the process of formative assessment but not necessarily for the same purposes. Student perceptions that interactions could enhance their learning and harm their relationships with others and their view of themselves led them to consider both the possible benefit and the potential harm of disclosing their ideas to others (teachers and peers). Moreover, students indicated that whether they pursued learning or performance goals and how they perceived teacher assessment purposes influenced their purposes for and willingness to participate in assessment interactions. Cognition, affect, conation and relationships with others were experienced by the students as inextricably intertwined with their learning and the formative assessment of it. Thus, the findings indicate that formative assessment contributes to the meaning of being a student, learner, knower and peer and of being a teacher in the classroom.

The findings of the study support the view that formative assessment is a sociocultural activity that may be described and is accomplished along three interdependent planes of the classroom, interpersonal and personal activity and meaning (Rogoff, 1995). On the classroom plane, formative assessment is accomplished through a process of apprenticeship and influences what it means to be a student (and a teacher). On the interpersonal plane, formative assessment is accomplished through a process of guided participation and influences what is taken and counts as school science and hence what it means to be a student (of science) in a particular classroom. It shapes how students view themselves and each other in the social milieu of the classroom. On the personal plane it shapes the language students use and how they feel about themselves as learners and knowers of school science.

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1. Introduction

1.1 Introduction

It was the last lesson on Monday. The students had already told the teacher they had studied separating mixtures in previous years so the lesson started with a class discussion of the terms filtering, decanting, crystallising and distilling. The teacher introduced these words by making links with the students' everyday experiences. They talked about "decanting" potatoes and compared filtering with sieving. Then she introduced a "thinking exercise". The students were to think about how they would separate various mixtures listed by the teacher. For example, they discussed how to separate broad beans and kidney beans, and also oil and water.

The teacher moved around the class talking with the students. A group called her over to confirm that they could filter oil and water. The teacher talked with them and then went to the preparation room, returning with oil, water and filter paper. She poured some oil on the filter paper. The students asked questions and made suggestions.

The teacher moved towards the front of the class. As she did so, another group asked how big salt crystals were and told her they would separate sand and salt using tweezers. The teacher stopped the class, showed them the oil and water mixture and said: "If you are not sure for oil and filter paper". She went on to demonstrate to the class that oil could not be filtered, and then questioned the students about the properties of salt and sand.

This episode is considered to be an instance of formative assessment because it involved the teacher gathering, interpreting and acting on information about the students' learning for the purpose of improving their learning. It is also viewed as formative assessment as it involved students testing out their ideas by discussing them with their peers and their teacher. This episode is one of many that were observed during the research reported in this thesis, the focus of which was formative assessment in science classrooms.

Formative assessment is important in education. It embodies a reflective decision-making function (Clarke, 1996) and serves as a means of information exchange or mutual feedback between teachers and students about the teaching and learning process. To this end, it is consonant with the primary purpose of school-based assessment espoused by the New Zealand Ministry of Education (1993a, p. 24), namely that of “improve[ing] students’ learning and the quality of learning programmes”.

Nevertheless, very little is known about how and to what effect formative assessment is accomplished as a part of routine teacher and student interactions. The term ‘formative assessment’ does not have an agreed meaning and many current assessment initiatives blur the distinction between formative and summative assessment (Black & Wiliam, 1998a). This chapter therefore starts with a brief overview of the purposes of assessment, followed by a definition and some examples of formative assessment. Sections 1.4, 1.5 and 1.6 provide an international perspective and the New Zealand background to the investigation. Section 1.7 outlines the research topic, the research context and the focus of other chapters in this thesis.

1.2 Purposes for assessment

Assessment in education is used for several different purposes, such as: a basis for the awarding of qualifications that affect students’ life chances, accountability, reporting to care-givers and others, and importantly, informing and improving teaching programmes and promoting students’ on-going learning (Black, 1993, 1998; Ministry of Education, 1993a, 1993b). Classroom-based assessment provides information for all these purposes and is usually categorised as diagnostic, formative or summative. Summative assessment sums up student learning and usually occurs at the end of a course of learning; it tends to be a structured and formal activity. Information gained is usually recorded and used for reporting to others or for qualification purposes (Ministry of Education, 1994a). Diagnostic assessment, on the other hand, is used to determine what students know and can do at the beginning of a course of learning. Within this study, diagnostic assessment is considered to be subsumed within formative

assessment (Black, 1993). Formative assessment informs student learning *during* the learning.

1.3 A definition of formative assessment

Assessment to enhance learning is variously referred to as educational assessment, (Blackmore, 1988; Willis, 1994), constructive assessment (Clarke, 1995; Johnston, 1989), formative evaluation, classroom evaluation and feedback (Black & Wiliam, 1998a). It is considered an activity that teachers engage in (Gipps, 1994; Ministry of Education, 1993a) and also an activity that requires both teacher and student involvement (Black, 1993).

Black and Wiliam (1998a, p. 7), in their review of international literature, define formative assessment as, “encompassing all those activities undertaken by teachers and/ or by their students, which provide information to be used as feedback to modify the teaching and learning activities in which they are engaged”. They emphasise that feedback is formative only if it is used by *students* to close the “gap” between what they know, understand and can do and the understandings sought by the teacher (Sadler, 1989). In contrast, Perrenoud (1998) argued that a broader definition of formative assessment was required when the goal of education was the development of self-regulated learners. He proposed that “all those evaluations are formative which contribute to the regulation of an ongoing learning process” (p. 80). According to Perrenoud, such actions include those that enhance the learner’s motivation and persistence. In New Zealand, *The New Zealand Curriculum Framework* policy document states that the curriculum and assessment should enable students to “develop [their] potential, to continue learning throughout life” (Ministry of Education, 1993a, p.3). Therefore, for the purposes of this research, formative assessment is defined as “the process used by teachers and students to recognise and respond to students’ learning in order to enhance that learning, during the learning” (Cowie & Bell, 1996). An assessment is considered formative if it results in feedback, and in action by the teachers and/or students intended to enhance student learning.

1.4 The nature of formative assessment

The episode used to introduce this chapter is an example of the process of formative assessment as it occurs in science classrooms every day. In this episode, a group of students initiated the assessment process by seeking feedback on their ideas. The teacher found out they did not have the understanding of the properties of oil, water, or an oil-water mixture required to solve the problems she posed and she acted to address this. Episodes such as this are often not recognised and acknowledged as occasions of formative assessment because they take place within teacher-student interactions, they are student initiated, they are not specifically planned for by the teacher, they are over in a moment and the information the teacher gained is ephemeral and unrecorded.

This particular episode is an example of strong formative assessment. Brown (1996) made a useful distinction between strong and weak formative assessment. She described strong formative assessment as taking into account how individual students make sense of the world and suggested that this is usually spontaneous, the information gained being ephemeral and acted upon rather than recorded. She described weak formative assessment as being more like repeated summative assessment in that it is tied to relatively fixed criteria, can be pre-planned and results in relatively crude adjustments to teaching and learning for the whole class. The focus for this research was on strong formative assessment.

1.5 Assessment: International trends

Internationally, formative assessment is currently a focus for policy and research development. One of the most striking features of this focus has been the shift from an emphasis on measuring student learning to considering how assessment impacts on, and might inform and enhance learning in the classroom (Black & William, 1998a; Broadfoot, 1996b; Gipps, 1994; Glaser, 1990b; Gitomer & Duschl, 1998; Moss, 1992).

Gipps (1994) identified Glaser (1963) as the first to propose attention be given to 'educational assessment'. She argued that this shift in attention was signalled by Glaser's suggestion that a move from norm to criterion referenced assessment be made. The realisation that testing in the form of external examinations was

having a negative impact on curriculum, teaching and learning provided the impetus to develop models of assessment to encompass and value a wider range of understandings, skills and attitudes (Brown, 1990; Broadfoot, 1996b; Darling-Hammond, 1994; Gipps, 1994; Gitomer & Duschl, 1998; Resnick & Resnick, 1992; Stiggins, 1991).

Current interest in formative assessment may also be linked to concerns about the mismatch between assessment practices and current views of intelligence and learning. Traditional models of assessment are based on notions of individual merit that first arose during the Renaissance (Broadfoot, 1996b; Willis, 1994). They are underpinned by an assumption that intelligence is a stable, unitary, limited personal capacity. This in turn led to the perception that assessment techniques not only measure learning (performance) but can predict future ability to learn (Broadfoot, 1996b; Carr & Cowie, 1997). These assumptions contrast with recent views of learning which construe it as a contextualised social process (Resnick, 1991). Current research indicates individuals have multiple intelligences that are neither innate nor fixed (Berlak, 1992a; Darling-Hammond, 1994; Gardner, 1983; Gipps, 1994).

1.6 Assessment: New Zealand trends

The importance of formative assessment in the New Zealand context may be linked with the publication of *The Assessment for Better Learning* document (Department of Education, 1989). Assessment to enhance learning continued to be a focus of Ministry of Education policy in the years proceeding and during the research reported in this thesis. *The New Zealand Curriculum Framework* (Ministry of Education, 1993a), *Science in the New Zealand Curriculum* (Ministry of Education, 1993b) and *Assessment: Policy to Practice* (Ministry of Education, 1994a) policy documents all recognise and emphasise the importance and value of assessment for informing learning:

The primary purpose of school-based assessment is to improve students' learning and the quality of learning programmes. (Ministry of Education, 1993a, p. 24)

The policy documents also indicate that summative assessment is necessary for reporting and accountability purposes (Ministry of Education, 1993a, 1994a; Hill, 1998). Students must be assessed so that schools can meet their obligations to monitor student performance against objectives, to overcome barriers to student achievement, to assess student achievement, to maintain individual records and to report on student progress (Ministry of Education, 1993c). Schools are monitored for compliance with these obligations by the Education Review Office, an agency that is independent of the Ministry of Education. The reports they produce on a school's effectiveness are public documents.

A problem arising from this is that school-based assessment has been primarily implemented for accountability purposes (Hill, 1996). Concern and confusion between requirements for better learning on the one hand and the provision of information for accountability purposes was such that during 1995 the Ministry of Education published a statement clarifying its position (Ministry of Education, 1995). In this statement the Ministry urged teachers to use their professional judgement in choosing assessment criteria, carrying out assessments and using the results to improve learning and the quality of learning programmes. The Education Review Office also outlined its views on issues relating to assessment in 1995 (Education Review Office, 1995). These, too, embodied the potential for conflict between assessment for improving learning and assessment for accountability.

Assessment and evaluation of students achievement are used to provide information to students and parents; to inform teaching and learning programmes; and to inform policy decision makers such as Government Ministers or boards of trustees. (Education Review Office, 1995, p.9)

This tension between assessment for accountability and assessment for improved learning is not confined to New Zealand but is an international phenomenon (Broadfoot, 1996b).

Assessment in New Zealand secondary schools has been further complicated by the policies of the New Zealand Qualifications Authority (NZQA), another independent governmental body. At the time of the data collection for this

research (1995-1996) the NZQA was developing a standards-based model of assessment for national qualification purposes. Standards-based assessment is a generic term used to mean assessment against standards where the standard may be specified in a description or through an exemplar. In 1995-1996, secondary schools were clarifying and documenting their assessment policies in order to gain accreditation from this authority to offer Unit Standards from the National Qualifications Framework. Unit standards qualifications are available to Year 11 to 13 students - not the students involved in this research. The unit standards for science were written in 1995 and implemented from 1996.

Alongside this, a system of national monitoring (The National Education Monitoring Project), using light sampling at Years 4 and 8 was developed. The monitoring project reports in-depth on individual and educationally compelling items (Crooks & Flockton, 1993, 1994). Science was assessed and reported on in 1995 (Crooks & Flockton, 1996). In addition to this, some New Zealand students in Years 4-5, Years 8-9 and the final year of school participated in the Third International Mathematics and Science Study (Garden, 1996, 1997). This ran from 1990 to 1997 and was reported in 1998. It analysed the science curriculum, described the educational context of science teaching and learning, and compared students' achievement across countries.

In summary, at the time of the data collection (1995-96) assessment was a focus for intense policy implementation and professional debate. Unfortunately, formative assessment, despite being identified as the primary purpose of school-based assessment, was lost from both the debates and resource development.

1.7 Learning in Science Project (Assessment)

In the early to mid 1990's, the Ministry of Education began funding a range of research and development projects on assessment. One such research project was the Learning in Science Project (Assessment). It was considered there was a need for research that could contribute to an understanding of the links between curriculum and learning, teaching and assessing at a time when a "new" science curriculum, *Science in New Zealand Curriculum* (Ministry of Education, 1993b) was being implemented. This curriculum document included specific reference to

assessment to improve learning. Prior to 1995 there had been little research investigating assessment and science.

The Learning in Science Project (Assessment) can also be seen as arising out of the findings of the Learning in Science Project (Teacher Development). The teachers involved in the LISP (Teacher Development) project identified assessment as one of the factors inhibiting their use of new teaching strategies in the classroom (Bell, 1993; Bell & Gilbert, 1996). Research by Bell and Pearson (1992) during the teacher development project found teachers used feedback on “better learning” conditions (for example, increased enjoyment, social co-operation, ownership, student confidence, and motivation) rather than “better learning” outcomes (for example conceptual development and the transfer of learning) when they evaluated their teaching. The teachers involved in the research expressed an interest in developing assessment strategies that could better portray student learning outcomes.

The main aim of the Learning in Science Project (Assessment) was to investigate assessment in science classrooms of students aged 11-14 years where the teacher of science took into account students' thinking. The research was designed to investigate:

1. the nature and purpose of the assessment activities in these classrooms
 2. the use of the assessment information by the teacher and the students to improve the students' learning in science
 3. the use of the assessment information by the teachers for their own learning, that is, teacher development
 4. the use of the assessment information in reporting to parents and others.
- (Bell & Cowie, 1997)

The research within the LISP (Assessment) project had three strands. The first involved interviewing 10 Years 7 - 10 teachers of science and 3 students taught by each teacher (a total of 30 students) to find out their views of assessment. The second involved classroom-based observation of the assessment activities of the ten teachers and their students. The third strand involved an investigation of teacher development activities during 10 teacher development days over the two

years of the research (1995-96). Further details are documented in Bell and Cowie (1997).

The LISP (Assessment) project led to the identification of the characteristics of formative assessment and the development of a model of the process (Bell & Cowie, 1997; Cowie & Bell, 1999). The characteristics identified were: formative assessment is responsive, it uses verbal and non-verbal sources of evidence, it is often a tacit process, it relies on professional knowledge and experiences, it is integral to teaching and learning, it is carried out by teachers and students for a variety of purposes, it is contextualised and is influenced by classroom factors, and it involves teachers in managing dilemmas. The model described two interrelated forms of formative assessment, namely planned formative assessment and interactive formative assessment. These forms differ with regard to teacher purpose and the nature of teacher planning (Cowie & Bell, 1999).

1.8 This study

This study incorporates the data and builds on the data analysis from the LISP (Assessment) project. The role of students in formative assessment was not fully documented in the research report to the funding agency (Bell & Cowie, 1997). This study considers more fully both student perspectives and the implications for formative assessment of how learning is viewed.

1.8.1 The rationale for the research

At the time of the data generation (1995-96), teachers of science were in the process of implementing a new national science curriculum (Ministry of Education, 1993). Local teachers had indicated they needed support to assess teaching and learning in a manner consonant with the views of learning underpinning this curriculum (Bell & Gilbert, 1996). Overseas research had indicated that teachers spend a considerable part of their professional life engaged in assessment (Stiggins & Conklin, 1992; Webb, 1992) but, as Broadfoot (1996a) noted, there had been, “a dearth of research into how, why and with what effect teachers use assessment in the classroom” (p. 33). Very little was known about the nature of teacher assessment and its relationship to learning in New Zealand

science classrooms. It seemed appropriate therefore to “enquire into what is currently happening” in order to “add to our capacity to act intelligently in difficult circumstances” (Torrance, 1992, p. 348).

Classroom-based research was considered essential. Research had indicated that learning is a context dependent process (Lave, 1988) and so the fragmented study of individuals was not seen as a viable basis for understanding complex practices such as learning and formative assessment in a classroom (Hennessy & Murphy, 1999; Tittle, 1994). The shift from a focus on the individual to “processes and constraints that are local, variable, context-dependent, and in some sense made” (Shweder & Sullivan, 1993, p. 502), described by Bruner (1990, p. 106) as a “contextual revolution”, was also evident in research on assessment that suggested student responses to assessment tasks were affected by the task (Bachor & Anderson, 1994; Murphy, 1995). Berlak (1992) had called for the development of a contextual theory of assessment that recognised that the meanings of scores was not universal but situated and contradictory, that technical decisions were not value-neutral but shape opportunity, and that cognitive achievement cannot be separated from affective and conative aspects. Alongside this, research that indicated that teacher and student questions and responses carried meanings about relationships and intentions as well as content (Carlsen, 1991; Mehan, 1979) indicated it would be important to consider the meaning of formative assessment in the context of the classroom. Therefore, it was considered it was important to attend to “what sort of shared knowledge currently exists between teachers and students about the purpose and process of routine classroom assessment” (Torrance & Pryor, 1995, p. 310). Thus teacher and student perceptions of formative assessment were sought.

Student perceptions and experiences were a particular focus for several reasons. The 12th Article of the United Nations Convention (Smith, 1995) states that it is important that children’s views are given due weight in matters affecting them. Assessment is one such matter as it affects their relationships and life chances. Close attention to student perspectives is also consistent with the recommendation that students be treated as “insiders rather than consumers” of education (Lansdown, 1994; Lemshire, 1998; Smith, 1995) and assessment (Sadler, 1989). Attention to student perspectives is also consistent with recent research and

development on formative assessment that has suggested that student involvement is vital (Fairbrother, Black & Gill, 1995). Another reason for considering student views was that research on teacher perspectives (Bachor & Anderson, 1994; Harlen & James, 1996) and practices (Savage & Desforges, 1995; Torrance & Pryor 1995) indicated teacher beliefs about assessment were diverse and influential (Gipps, Brown, McCallum & McAlister, 1995). Given the impact of assessment on their lives, there was every reason to expect students' perspectives and experiences would also be diverse and influential. Consideration of student views seemed particularly important at a time when many of the newer forms of assessment were implying changes in roles for teachers *and students* (Perrenoud, 1991) and there was no reason to expect that students would find change any easier than teachers (Corbett & Wilson, 1995).

A further reason for considering students' views was that student voices are noticeably absent from educational research (Erickson & Schultz, 1992; Smith, 1995), including research on assessment (Clarke, 1995; Moss, 1992). Hence a deliberate aspect of this research was to involve students as "authentic chroniclers" and critics (commentators) of their perceptions and experiences (Delpit, 1988, p. 207).

Another reason for considering teacher and student perspectives of the nature of assessment in the classroom was that traditional criteria for quality assessment such as validity, reliability, fairness and objectivity had been critiqued from within a constructivist view of learning, particularly in relation to the relative importance of reliability and validity (Champagne & Newell, 1992; Crooks, Kane & Cohen, 1996; Guba & Lincoln, 1989), and found wanting. The definition of validity and what it might mean for newer forms of assessment and assessment for formative purposes was under debate and other criteria were being developed (Bachor, Anderson, Walsh & Muir 1994; Galbraith, 1993; Guba & Lincoln, 1989; Linn, 1994; Moss, 1992; Wiliam, 1992). It was hoped that listening to student (and teacher) voices would provide an opportunity to investigate what counted as "good" (Ayres, 1990; Lincoln, 1995), given that it is they who must do the learning.

1.8.2 The researcher

A researcher's beliefs and experiences form part of the background to any research. In this case, I had taught mathematics, some junior science, and physics to Year 9 to 13 students over a period of 17 years. I viewed teaching as a complex, challenging and important profession involving care for both students and the subject. I had a strong commitment to actively working to improve my teaching, with prior experience of LISP projects providing strategies for doing this.

My interest in student thinking (Cowie, 1995) was the stimulus for my involvement in the LISP project. I saw the project as an opportunity to learn more about student thinking and student experiences of assessment. It was my belief that attending to student perspectives might facilitate the development of new approaches to assessment.

Prior to participating in the LISP project I had been actively involved in formal assessment procedures at my school. I was responsible for managing Sixth Form Certificate, monitoring New Zealand Qualifications Authority enrolments and developing the documentation for New Zealand Qualifications Authority accreditation to offer Unit Standards. At the beginning of the study, I viewed formative assessment as integral to teaching; I saw it as a process of noticing and appreciating the significance of student ideas at a time when it was possible to act to challenge these ideas. I considered that what I noticed as a teacher was dependent on my prior knowledge and experience of students, the subject and the particular student, and my commitments at the time. I was particularly concerned that this informal, ongoing and responsive form of classroom-based assessment would become de-valued and /or replaced by focused assessment tasks as a consequence of teacher and school-based concerns. This included pressure for formal and visible accountability to those outside the classroom.

1.8.3 The research questions

The intention of this study was to examine and explore teacher and student perceptions and experiences of formative assessment in the context of current classroom practice in order to explicate and provide a theoretical account of the

process. The research questions that guided the study and framed the data generation were:

1. Was formative assessment being used and, if so, what was the nature of this formative assessment and how was it perceived and experienced?
2. What theorising can be used to describe and explain the formative assessment identified?

1.8.4 Outline of the thesis

The next chapter reviews the literature on (i) current views of learning, (ii) classroom research on and current theories of formative assessment, (iii) factors that influence student learning and (iv) validity. It argues for the need for further research into the nature of formative assessment as perceived and experienced by teachers and students and for the need for further consideration of what might serve as validity in formative assessment.

Chapter 3 outlines the research methodology. Chapters 4, 5 and 6 set out the observational and interview data. Chapter 4 includes seven case studies of formative assessment as identified in the classrooms. Formative assessment in each of the classrooms is described in terms of the setting and the teachers' views and illustrated by selected episodes of assessment. Chapter 5 maps out students' perceptions and experiences of formative assessment. The focus in this chapter is on the breadth and diversity of student perceptions and experiences. Chapter 6 analyses and synthesises the case studies (Chapter 4) and student views (Chapter 5) with data from the teacher development days to propose a view of formative assessment as a situated, social, intentional and meaning-making activity. Chapter 7 summarises the study and outlines the implications for research in formative assessment.

2. Formative assessment

2.1 Introduction

The first recorded educational use of assessment was in China, over 2000 years ago when meritocracy, rather than aristocracy, was used to select people for entry to the civil service (Chu, 1996). Today, assessment based on notions of competence (can the individual fulfil the role or perform the task), competition (selection of individuals on the basis of their competence) and control (assessment to regulate the actions of teachers, students, institutions and systems) has come to be viewed as integral to the mass provision of education (Broadfoot, 1996b). In recent years, evidence of the impact of assessment on teaching and learning has led to the recognition that assessment needs to support learning rather than just measure current and past achievements (Glaser, 1990b). Attention has shifted to the connections between assessment and learning in the hope that classroom assessment might enhance learning (Black & Wiliam, 1998a; Brown, 1990; Gipps, 1994; Glaser, 1990b). Assessment for this purpose is known as formative assessment. It is this type of assessment that is the focus of this chapter.

Old models of assessment are based on the assumption that assessment is a neutral, objective “technical” activity which could be used to measure students’ current competencies and skills (Blackmore, 1988; Galbraith, 1993; Gipps, 1994; Willis, 1992, 1994). These models derive from a view of knowledge as objective and the learner as a rational individual. They assume intelligence is a fixed, innate individual capacity and so assessment is able to predict future performance. These assumptions contrast with new conceptions of learning and intelligence, which recognise that learning requires active participation with others in a setting, and that a person’s intelligence is neither unitary, limited or bounded. This study argues for and investigates the viewpoint that formative assessment is a contextualised social process in which students and teachers together are active and intentional participants.

At present, there is no comprehensive theory for formative assessment (Black & Wiliam, 1998a) but any theory of formative assessment needs to take account of

what is known about classrooms and classroom-based assessment and how learning is viewed. Consequently, this chapter has two aims. First, it is argued that assessment is a contextualised and social, rather than a technical activity, and, at the same time, it is argued that views about learning need to be considered in order to theorise formative assessment. To this end, Section 2.2 frames and examines research on the nature, influences on and effects of classrooms and classroom assessment to discuss the features of formative assessment. This section paves the way to a focus on the implications for formative assessment of how learning is viewed (Section 2.3). The research questions that emerge from the discussion are set out in section 2.4.

2.2 The nature of formative assessment

A search of the literature revealed a number of debates related to the characteristics of formative assessment. These were about (i) the nature of the relationship between formative and summative assessment, (ii) the nature of validity, and (iii) the nature of the process of formative assessment. These debates frame this section. It is argued that they construe formative assessment as a social activity.

2.2.1 The relationship between summative and formative assessment

The first debate in the literature on the nature of formative assessment concerns the extent to which an assessment can serve both formative and summative functions. This debate highlights the importance of purpose in the assessment process. Current definitions of formative assessment emphasise that it is the feedback and action to enhance learning that distinguishes formative assessment from summative assessment (Black, 1993; Gipps, 1994; Harlen & James, 1996; Ministry of Education, 1993a; Perrenoud, 1998; Sadler, 1989; Torrance, 1993).

Some writers contend that an assessment may be able serve both a formative and a summative function. For example, Harlen and James (1996) suggest that teachers can review *evidence* gathered for formative purposes in relation to criteria that are the same for all students when they need to make summative decisions. Wiliam & Black (1996) argue that all assessments have the potential to

serve a summative function but only some have the *additional* capability of serving a formative function. However, both Black (1995c) and Harlen (1994, 1995, 1998) caution that teacher assessment for summative purposes may impair its formative role. They propose that teacher confusion about the nature of formative assessment may explain why teachers confuse formative assessment with ongoing summative assessment that results in no action to enhance learning.

In contrast, Gipps (1994) argues that the formative and summative purposes of assessment are incompatible because they imply significantly different roles for teachers and students. Summative assessment requires the teacher to act as a judge of student learning and often involves stopping teaching to measure progress. Formative assessment tends to be continuous, informal and integral with teaching (Cowie & Bell, 1996; Hattie & Jaeger, 1998; Ross, Radnor, Mitchell & Bierton, 1993).

In practice, classroom assessment lies on a continuum from informal formative to formal summative (Harlen, 1998; Ross, Radnor, Mitchell & Bierton, 1993). This may explain why students are suspicious of teacher motives and reluctant to participate in assessment (Perrin, 1991). The sources of the confusion for teachers and students and the tensions between formative and summative assessment are issues deserving of special attention (Black & Wiliam, 1998a).

2.2.2 Validity and formative assessment

The second debate in the literature on the nature of formative assessment concerns the nature of validity. It is generally agreed that validity is the key consideration in evaluating the quality of formative assessment (Gipps, 1994; Wiliam & Black, 1996). The notion of validity was initially developed to ensure consistency of shared meanings among interpreters of summative assessment information (Wiliam & Black, 1996). Recently, the notion of validity has been reformulated to include consideration of the adequacy and appropriateness of the consequences that arise from the interpretations and actions that are made on the basis of an assessment. In Messick's (1989a) words:

Validity is an integrated evaluative judgement of the degree to which empirical evidence and theoretical rationales support the adequacy and appropriateness of inferences and actions based on test scores or other modes of assessment. (Messick, 1989a, p. 13)

In terms of formative assessment, the concern is with the consequences for teaching and learning (Black, 1995a, 1998; Cowie & Bell, 1996; Sadler, 1989; Wiliam & Black, 1996). Validity for this purpose is called consequential validity (Darling-Hammond, 1994; Glaser, 1990b; Moss, 1992; Shephard, 1993).

Very little research has explored the implications of consequential validity for formative assessment. Harlen (1995) and Wiliam and Black (1996), however, suggest that teacher formative interpretations and actions are always provisional, discussed and negotiated as part of the process of using the information. For example, a teacher might revisit ideas when a student looks puzzled or pose further questions to a student who is able to explain an idea.

Recently, Crooks, Kane and Cohen (1996) drew attention to the idea that the validity of an assessment may be undermined at any stage of the process. They proposed that assessment be viewed as a chain of eight linked stages: administration, scoring, aggregation, generalisation, extrapolation, evaluation, decisions and impact. In their view, the consequences of an assessment, including a formative assessment, need to be appraised at each of these stages.

The intended and unintended social consequences of assessment are also considered by Messick (1989b) to impact on the validity of an assessment. This aspect is of special interest in formative assessment because teachers and students must live with the consequences of their assessment actions. Moreover, classroom assessment has been found to disrupt relationships and to impact on student motivation, self-esteem and conation (see section 2.2.3). However, this aspect of validity has not been explored in the literature.

Validity is not just a measurement principle but is representative of wider social values that are invoked whenever evaluative judgements and decisions are made (Messick, 1989a, 1994; Moss, 1992). Thus understood, questions about the nature

of validity concern not only what counts as an acceptable consequence but also who should decide what is acceptable.

Student and teacher voices have been noticeably absent in evaluations of tests developed by assessment specialists (Moss, 1994) but in the case of formative assessment it would seem essential that their views be taken into account (Tittle, 1989). Cowie and Bell (1996) argue that *student* perspectives are particularly important as it is they who must do the learning. They raise questions about the impact of the differences in teacher and student goals and students' ability to influence the definition of validity, given teachers' institutional power and authority.

Another consideration in the evaluation of the consequences of formative assessment is that assessment is a moral and ethical activity (Drummond, 1993; Gipps, 1994). It may be considered thus because it involves making and acting on choices. Such choices shape not only the curriculum (Broadfoot, 1990) but teaching and learning as well, which in turn affects how students see themselves and how others view them (Berlak, 1992; Brown & Knight, 1994; Gipps, 1994; Wiliam, 1994). According to Gipps (1994) and Murphy (1995), this means that assessment should be equitable; an attempt should be made to ensure the concerns, contexts and approaches of one group do not dominate. Cowie and Bell (1996) argue that equity also involves equitable access by all students to formative help from the teacher. However, this issue is in need of further investigation.

Conceptualising the ethical aspects of assessment as similar to those involved in the conduct of educational research is one way an investigation into the ethics of formative assessment might proceed. Formative assessment and interpretive educational research seek to elicit and understand meanings in context. Moreover, the introduction of new research questions and methodologies have given rise to questions about the nature of validity in research just as it has in formative assessment. This perspective draws attention to the issues of confidentiality and potential harm (Erickson, 1998, see also Chapter 3). The meaning and relevance of these notions for formative assessment that takes place in the semi-public setting of the classroom is an area for further study.

Another link between research and assessment is that of the notion of trustworthiness. Moss (1992) and Scheurich (1996) argued that validity is a social discourse through which trustworthiness is established. Recently, trustworthiness has been proposed as an alternative way of conceptualising validity in research (Guba & Lincoln, 1989; Scheurich, 1996) and assessment (Cowie & Bell, 1996; Moss, 1994). Guba and Lincoln (1989) argued that research is trustworthy to the extent that other researchers are prepared to use the findings as a basis for their work. The notion of trustworthiness would seem to be important in formative assessment that is validated in terms of the consequences of teacher and student actions to enhance learning. All the more so since trust has been found to be important in students' acceptance of changes in teaching practice (Northfield, 1992; Thomas, 1999) and to their participation in assessment initiatives (Torrance, 1991). Student and teacher perceptions of trustworthiness in formative assessment are an area for exploration in this study.

In review, consequential validity is a key concept in the evaluation of formative assessment. This concept is representative of social values but “current conceptions of validity provide no guide as to what “ought” to be going on, merely a theoretical framework for discussing what is going on” (Black & Wiliam, 1998a; p. 55). Current conceptualisations of assessment that construe it as a moral activity suggest validity will be both a technical and an ethical issue. Student and teacher perceptions of what validity might mean for formative assessment, particularly in relation to effective models of learning is an important area for research on formative assessment (Black, 1998, p. 54).

2.2.3 Formative assessment in practice

A third debate in the literature on the nature of formative assessment concerns how it is realised in practice. In the preceding sections it has been argued that, at the very least, formative assessment involves feedback and should be appraised with regard to its consequences for learning and teaching. However, simply asserting that formative assessment involves feedback does not explain how it is accomplished in practice (Torrance, 1993). In the next sections, current practice is discussed in terms of theories of and recommendations for practice and in terms of student, teacher and classroom interaction perspectives on practice. It is argued

that formative assessment is a social process that necessarily involves the active participation of teachers and students.

Theories of and recommendations for the practice of formative assessment

There are a number of theories in the literature of what formative assessment should be like. Sadler (1989), for instance, set out in detail the logical implications for practice of viewing learning as a “multidimensional” and non-linear process (p. 123). In his words:

The indispensable conditions for improvement are that the student comes to hold a concept of quality roughly similar to that held by the teacher, is able to monitor continuously the quality of what is being produced during the act of production itself, and has a repertoire of alternative moves or strategies from which to draw at any given point. (Sadler, 1989, p. 121)

Conceptualised this way, formative assessment requires the learner to perceive a “gap” between a desired goal and his or her present state (understanding, knowledge or skill) and to act to attain the desired goal. Thus understood, formative assessment necessarily involves students in self-assessment. It is generally consonant with meta-cognition (White, 1992) and self-regulated learning (Butler & Winne, 1995; Schunk & Zimmerman, 1996). However, for student action to be aligned with the teacher’s goals the student must share and value these. Thus, as Sadler made clear, teachers have an important role in formative assessment in both the communication of the criteria for a quality performance and the provision of feedback to students. For teachers the practical implications of Sadler’s view are that they need to have a concept of goals of learning and possible paths of progression towards them. They need to be able to recognise where students are at in their learning and to provide feedback to help the students to close any gaps. This feedback also needs to foster student self-assessment. However, if teachers are to be able to provide feedback to help students close the gap, then students must be willing and able to disclose what they do and do not know. Thus understood, Sadler’s formulation of formative assessment requires the active involvement of teachers and students.

It needs to be emphasised however, that Sadler's (1989) formulation for the practice of formative assessment is atypical; in other cases the view of learning held by the author/ researcher tends to be left implicit in both the literature of recommendations for practice and in research on assessment (Broadfoot, 1996a; Black & Wiliam, 1998a). As Perrenoud (1998), Pollard, Broadfoot, Croll, Osborn and Abbott (1994) and Black and Wiliam (1998a) point out, the relationship between formative assessment and models of teaching and learning is in need of urgent attention.

Nevertheless, there is a general consensus agreement that to be effective, teacher formative assessment needs to be ongoing rather than simply at the end of a sequence of work. It needs to generate information on what students are learning not simply if they have learnt what has been taught (Clarke, 1995; Eisner, 1993; Stiggens, 1991; Willis, 1994). The strategies used must be able to gather information on what, why and how students learn, and that information must be sought on what students know rather than what they do not (Lally & Hurst, 1992). When learning is viewed as a social process, it is suggested that information is needed by the teacher on the knowledge constructed by groups (Black, 1998; Eisner, 1993) and what students could learn next (Torrance & Pryor, 1995).

There is also substantial agreement that making sense of evidence of student learning involves judgement (Hager & Butler, 1996; Sadler, 1989) and that such judgement needs to be criterion-referenced in terms of specific content or skills (Black, 1995c, 1998; Harlen, 1996; Sadler, 1989). It is generally recognised that the use of pre-determined criteria serves to strengthen the link between teaching and assessment rather than the link between learning and assessment (Blenkin, 1992; Torrance, 1993). To understand student performance multiple criteria need to be developed on the basis of what is "salient" at the moment (Sadler, 1989), rather than what has been taught (Biggs, 1995; Blenkin, 1992; Davis, 1995; Osborne & Freyberg, 1985; Willis, 1994). This means that the criteria involved in making sense of student actions need to be emergent rather than predetermined.

Alongside this, it is recommended that formative assessment be student-referenced. In this case a student's ideas are compared with his or her own previous understandings and so the teacher may take into account a student's prior

understandings, effort, progress and particular circumstances (Drummond, 1993; Cowie & Bell, 1996; Harlen, 1994, 1996; Harlen & James, 1996; Scott, Asoko, Driver & Emberton, 1994; Tunstall & Gipps, 1995; Shymansky & Kyle, 1992). Seen this way, teachers' knowledge of when and where students can do something enriches, rather than biases, their interpretations (Harlen, 1995). Student referencing in this sense supports a constructivist view of learning because it is assumed that students are making sense of their experiences and learning involves a process of conceptual change. In practice, student and criterion and student referencing are needed to understand how a student's ideas compare with those of scientists and to generate information that will be effective in persuading the student to actively reconsider his or her ideas (Harlen & James, 1996; Cowie & Bell, 1996).

Another perspective on interpretation is that it is a social process (William, 1994a). Davis (1993), for instance, queried whether teacher assessment could ever be simply criterion-referenced, given the incompleteness of the information gained about student learning. He proposed students always needed to be involved. Others, such as Genishi (1997) argue that interpretation involves the negotiation of criteria with students and a search for intersubjectivity (shared meaning). Current research supports student involvement in the ongoing negotiation of assessment criteria (Duschl & Gitomer, 1997; Tanner & Jones, 1994).

In current recommendations for formative assessment it is crucially considered to involve action to enhance learning. The recommendation is that this involves the provision of individual feedback and action to enhance learning (Black, 1993). Brown (1996), for instance, queried whether actions with the class were sensitive enough to be formative (see also Harlen, 1998). However, the exact nature of such action is debated. Some writers (for example Sadler, 1989; Black & William, 1998a), assert that formative feedback must help students close the gap between their current understandings and those desired by the teacher. Others, (for example Perrenoud, 1998), argue that actions that enhance student motivation and conation may be considered formative. These two perspectives stem from different views of both learning and the goal of education. Sadler (1989) and Black and William (1998a) identify learning with student understanding of the

knowledge prescribed in the curriculum, whereas Perrenoud considers self-regulated learning as the goal of schooling.

Student involvement in self-assessment is an important (some argue essential) component of formative assessment as it provides both a source of information for teachers and an action to enhance student learning (Black, 1993, 1995c; Sadler, 1989). Active student involvement is a feature of many recently developed assessment approaches and strategies that blur the distinction between formative and summative assessment (Darling-Hammond, Ancess & Falk, 1995; Duschl & Gitomer, 1997; Ross, Radnor, Mitchell & Bierton, 1993; Torrance, 1992; White & Gunstone, 1992). Within research to develop teacher formative assessment, Parkin and Richards (1995) and Fairbrother (1995) found that students' commitment to learning was strengthened when they took more responsibility, in collaboration with the teacher, for monitoring their own progress, evaluating their own strengths and weakness and devising strategies for improving their learning (Boud, 1996; Fairbrother, Black & Gill, 1995; Klenowski, 1995). However, students coming to share their teacher's criteria for evaluating their work is not a simple matter. Some suggest that teachers need to make their criteria more explicit (Klenowski, 1995) but others (Claxton, 1995; Wiliam, 1994a) argue that criteria need to be left implicit so as not to distort learning. Blanchard (1995) goes a step further and challenges the authenticity of much of what is called self-assessment when students are required to adopt teacher criteria. He contended that many criteria can be used to make sense of a situation and that improving one's criteria constitutes learning.

More recently, it has been argued that to overcome the difficulty of formative assessment being a mere adjunct to a learning programme, it must form an integral part of teaching and learning (Black & Wiliam, 1998; Harlen, 1998; Hattie & Jaeger, 1998). To this end, it is often asserted that it must be planned for by teachers when they develop learning experiences. This way they can both "own" the plan and take action during the teaching and learning (Black, 1995a, 1998; Sutton, 1995).

Alongside this, some writers point out that formative assessment is an essential aspect of the informal interactions that are a part of all effective teaching and

learning (Clarke, 1995; Pratt, 1994). Newmann, Griffin and Cole (1989) described this process as “assessment while teaching”. The advantages of teacher assessment through informal interaction are that it allows teachers to gather information on the processes of student learning and aspects of students' social, personal and intellectual development which cannot be easily gained in other ways (Bachor & Anderson, 1994; Stiggins & Conklin, 1992), that the information obtained is "robust" because students are not attempting to guess what is in the teacher's mind (Wiliam & Black, 1996) and that "behaviour is best understood by identifying people's values and the components of competence they tend to display spontaneously in pursuit of their valued goals" (Raven, 1992, p. 55). The disadvantages are that not all students may be assessed, the teacher may have to wait a considerable time to see evidence of some aspects of learning and they may not recognise the significance of what they see (Harlen, 1995; Wiliam & Black, 1996). As Perrenoud (1991) pointed out, a combination of formal and informal formative assessment would seem to be most useful. The interaction between planned and ongoing informal assessment is an area for further investigation in this study.

In review, current recommendations suggest that teachers and students must be actively involved in formative assessment. However in the current discussions, very little consideration is given to, or account provided of, the tentative, value-driven nature of formative assessment, nor of how it might be perceived and accomplished by teachers and students as an interpersonal interaction in the complex social milieu of the classroom. According to Black and Wiliam (1998a), this is an area deserving of further study.

Students, teachers and classroom interaction and the practice of formative assessment

The second aspect of the nature of formative assessment in practice is that of teacher and student perceptions and experiences in the context of the classroom. Very little research has explored teacher and student perceptions and experiences of the purposes, processes and effects of formative assessment, despite there being an extensive and growing literature documenting the relationship between assessment and aspects of learning (Ames, 1992; Crooks, 1988; Dweck, 1986; Dweck & Leggett, 1988), describing and evaluating the

impact of a variety of assessment initiatives and innovations (Airasian, 1994; Broadfoot, 1996a; Darling-Hammond, Aness & Falk, 1995; Duschl & Gitomer, 1997; Fairbrother, Black & Gill, 1995; Klenowski, 1995; Roth & Roychoudhury, 1992; Resnick & Resnick, 1992; Sutton, 1995; White & Gunstone, 1992) and describing the nature of classrooms and classroom interactions (Barnes, 1976; Cazden, 1988; Lemke, 1990; Mehan, 1979; Mercer, 1995). This section examines what literature there is with respect to aspects of (i) student and (ii) teacher participation in and practice of formative assessment and discusses (iii) the implications of research on classrooms and classroom interaction. It is argued that the tensions revealed within and between these three perspectives construe formative assessment as a situated social process.

(i) Students and formative assessment

Student experiences of classroom formative assessment are important (Sadler, 1989) but, like their subjective experiences of the curriculum (Erickson & Shultz, 1992; Pollard, Thiessen, & Filer, 1997), have received very little attention. Dimensions of student perceptions and experiences with relevance to their participation in formative assessment include student goals, student disclosure and the impact of assessment. This section looks at these three dimensions.

(a) Students pursue a range of goals

With reference to goals generally, Hattie and Jaeger (1998) assert that, "goals regulate action and explain the nature of the link between the past and the future" (p. 112). In terms of student involvement in formative assessment, it is generally agreed that the teacher's intended learning outcomes need to be shared with and valued by the students (Black, 1995a; Boud, 1995; Clarke, 1995; Fairbrother, 1995; Klenowski, 1995; Harlen & James, 1996; Raven, 1992). However, research that indicates students pursue a range of their own academic, social and task goals makes this proposition problematic.

Students may focus on task completion and ways of obtaining the teacher's approval in addition to, or instead of attending to the logical features of a task. For instance, being "right" has been identified as an important student goal (Carr, 1996; Swain, 1991). These two different academic achievement goal orientations, variously termed performance and learning (Dweck, 1986), mastery and

performance (Ames & Archer, 1988), ego-involved and task-involved (Nicholls, Cobb, Yackel, Wood & Wheatley, 1990) and mastery and helplessness (Sylvia, 1994), have been identified in research and classroom settings. In the first case students are motivated to complete tasks so they obtain good marks and look competent in comparison with their peers. They avoid taking risks and tend to have a fixed view of their intelligence. In the second case, students are motivated by the desire to understand. They are more likely to have a flexible view of their intelligence and to view effort as helpful. Students may also seek to “get by” (Perrenoud, 1991, p. 92) and to avoid work (Nicholls, Cheung, Lauer & Patashnick, 1989). Thus understood, learning may not be students’ only or most important goal.

The significance of student goal orientation in formative assessment is emphasised by research that has indicated students seek help (ask questions) for several reasons, namely out of genuine curiosity, as a pro-active outcome of self assessment and as a result of learned helplessness (Biddulph, 1996; Butler & Neuman, 1995; Dweck, 1986; Gallas, 1995; Newman & Schwager, 1995; Nelson-Le Gall, Kratzer, Jones & DeCooke, 1990; Roth, 1995a). It follows that student questions are not necessarily a robust source of information about students’ current uncertainties and interests.

Adding to the complexity of student (and teacher) formative assessment, recent research has indicated that students are motivated to achieve social as well as academic goals and that these are often intertwined (Blumenfeld, 1992; Juvonen & Wentzel, 1996; Urdan & Maehr, 1995). In terms of social goals, students work to maintain and establish interpersonal relationships with peers and teachers, to develop social identities and a sense of belongingness, and they observe and model social skills and standards of performance displayed by others (Carr, 1997; Goodenow, 1993; Harter, 1996; Hickey, 1997). It seems clear that students need to be socially as well as intellectually adept in order to be successful (Wentzel, 1996; Mehan, 1979). They are rewarded for acting in ways that are valued by both teachers and peers. It should be noted that peer expectations may be different and in extreme cases completely opposite to those held by the teachers (Measor & Wood, 1984; Pollard, 1987; Woods, 1990). These tensions regarding student social and academic goals, including their motivations and goals for involvement

in formative assessment, are in need of urgent attention. This is especially so at a time when theorists have moved to the view that learning is an inherently social activity (Blumenfeld, 1992; Hickey, 1997; Marshall, 1992; Oldfather & Dahl, 1994; Wigfield, Eccles, & Rodriguez, 1998).

Another aspect of the goals that students pursue in the classroom is the criteria they use to evaluate their ideas. Given that scientific knowledge is now generally considered to be socially constructed, the means used to "warrant" or justify moving between data and explanations are important (Driver & Newton, 1997). The means which students use to adjudicate between alternative explanations may be seen as indicative of the warrants they use to assess the viability of their ideas (Ritchie, Tobin & Hook, 1997). Research in science classrooms has consistently found that students use a range of criteria to evaluate their ideas some of which are context specific and include the need for social agreement (Driver, 1989a; Solomon, 1987). Recent research suggests that the various reasons students have for adjudicating between explanations include accepting the authority of the teacher, text or peer as the "final warrant of viability" for their understandings, testing the coherence of their explanation in comparison with other knowledge claims, and testing the ability of their explanation to predict what would happen in a practical situation (Driver, Leach, Millar & Scott, 1996; Ritchie, Tobin and Hook, 1997; Tobin, McRobbie & Anderson, 1997; Tobin, Tippins & Hook, 1995). Students have also been found to elaborate on, refine and test the viability of their constructions through interaction and negotiation with their peers and the teacher (Wheatley, 1993).

The criteria students use to evaluate their ideas are important because they influence students' approach to learning. Driver (1989a), for instance, found that the use of an external warrant disempowered students with respect to making sense of science themselves. Furthermore, research that indicates students use different criteria in mathematics (Frid & Malone, 1995; Mason, 1996) suggests that the criteria students use in science maybe related to how they view the nature of science (Driver, et al., 1996). In terms of formative assessment, the question therefore is how and if formative assessment influences the warrants or criteria students use to evaluate their ideas and if there is a relationship between the criteria they use and the feedback they utilise.

Student perception of the purposes for task engagement is another aspect of their goals that impacts on their participation in assessment activities. Classroom-based researchers have found there is often a mismatch between teacher intentions and student perceptions of the purposes for tasks and task engagement (see, for example, Alton-Lee, Nuthall & Patrick, 1993; Briscoe, 1993; Doyle & Carter, 1984; Loughran & Northfield, 1996; Perret-Clermont, Perret & Bell, 1991). Tasker and Freyberg (1985), working in science classrooms with 14 year olds, found students did not necessarily identify the salient skills or outcomes of the activity or make sense of the task as a scientist might and so they did not achieve the learning outcomes the teacher intended. In terms of assessment tasks, Harris (1994) found the Year 11 students she studied valued their involvement in records of achievement but the Year 9 students saw the time and effort involved as an imposition. Likewise, Torrance (1991) found that while students were generally positive about self-assessment as part of a record of achievement, they considered some questions to be overly intrusive within the context of written assessment. They experienced the assessment process as institutionalised when most teachers asked "the same boring questions". In another example, Perrin (1991), working with primary students in the Geneva Canton, found students believed that teacher assessments were for the school's and their parents' benefit. The weak students believed the purpose was to make them work and hence were reluctant to participate. Thus understood, student perceptions of the purpose for task engagement are important as they influence the nature of their participation, the goals they set and the feedback they attend to and utilise (Butler & Winne, 1995).

(b) Disclosure

Disclosure is the second important aspect of formative assessment from a student perspective. Disclosure, according to Wiliam (1992, p. 13), is the "extent to which it [the task] produces evidence of attainment from the individual in the area being assessed". In formative assessment, disclosure also includes the extent to which information is revealed about how, what and why a student does not understand as this may also be used to inform action (Cowie & Bell, 1996). Obviously, students need adequate opportunities to disclose or display their ideas if teachers are to learn what students know, understand, feel and can do.

Disclosure is more than a technical issue. All assessments take place in a social setting and so students must not only be able to represent what they feel, know, understand and can do, but they must also *want* to inform the teacher and behave in ways that demonstrate that they possess a particular kind of knowledge or skill (Broadfoot, 1990; Traub, 1990; Wiliam, 1992). To date, no research has explored students' perceptions of what aspects of assessment tasks and task organisation impact on disclosure. However, classroom-based research indicates that tasks and task engagement not only have cognitive meanings but social meanings as well (Erickson & Shultz, 1992). The social relations surrounding and social meanings of tasks are relevant to formative assessment because they influence how students act in several ways, such as how they feel about doing the task given their relationships with the teacher and peers, whether seeking help affiliates them with others or is seen as a disgrace, and where the task fits with their learning goals (Erickson & Shultz, 1992).

The notion of who the audience is for any student disclosure of interest (or disinterest) and competence (or incompetence) (Cazden, 1988; Erickson & Schultz, 1992) seems to be particularly important. Research suggests students suppress evidence of what they know and will not ask questions because they fear embarrassment or because they do not want to appear too "brainy" (Good & Brophy, 1997; Ladson-Billings, 1996; MacNamara & Roper, 1992; Murphy, 1995; Wiliam, 1992, 1996). For example, the fourteen year old students interviewed by Harter (1996) chose not to ask questions because peers and teachers might not listen to or support them, the questions might pose a threat to their relationships (others will be mad at me), they were unsure of their ideas and because they were concerned they would feel embarrassed (see also Blumenfeld, 1992). Students sometimes resent and misinterpret differential treatment from a teacher in a classroom setting (Drummond, 1993; Good & Brophy, 1997). It seems that students may evaluate the benefits and risks of disclosing their ideas as part of the process of task engagement (Doyle, 1986) and learning (Claxton, 1984). The reasons students have for minimising the disclosure of their ideas needs further investigation.

(c) Students and the effects of formative assessment

The effect of formative assessment on students and their learning is the key consideration in any discussion of formative assessment. Black and Wiliam (1998a, 1998b), on the basis of a review of international literature published since 1988, concluded that formative assessment can and does improve learning. To use their words:

There is a body of firm evidence that formative assessment is an essential feature of classroom work and that development of it can raise standards. We know of no other way of raising standards for which such a strong prima facie case can be made on the basis of evidence of such large learning gains. (Black & Wiliam, 1998b, p. 12)

The identified gains were greatest for disadvantaged and low-attaining learners which, Black and Wiliam (1998a) argue, makes formative assessment a particularly significant intervention strategy. However, it is widely recognised that classroom assessment also affects the shape and nature of students' educational experiences and hence their learning approaches, motivations, sense of identity and relationships.

Crooks (1988), on the basis of a comprehensive international review, described the direct and indirect, intended and unintended effects of classroom assessment thus:

Classroom evaluation affects students in many different ways. For instance, it guides their judgement of what is important to learn, affects their motivation and self-perceptions of competence, structures their approaches to and timing of personal study (for example spaced practice), consolidates learning, and affects the development of enduring learning strategies and skills. It appears to be one of the most potent forces influencing education. (Crooks, 1988)

More specifically, classroom assessment can encourage students to take surface, deep or strategic approaches (Crooks, 1988; Harlen & James, 1996; Boud, 1995; Harlen, 1996). For instance, assessment that emphasises the recall of isolated facts

has been found to encourage surface learning approaches where students simply seek to successfully complete tasks. Classroom assessment is also known to impact on learners' achievement goal orientations (Ames, 1992) and to influence what they attribute success and failure to (Ames, 1992; Little, 1985; Weinstein, 1989). These influences are important in formative assessment as social rewards in the form of grades, stars and stickers, which do not help students identify what they know or what to do to improve, can lead students to attribute failure to low ability, luck or teacher bias. In the long run the effect of this is to reduce student motivation, confidence and effort (Black, 1993, 1998; Lepper & Hodell, 1985; Pryor & Torrance, 1996; Stipek, 1993).

A further important effect of classroom assessment is its impact on how students feel about themselves as learners (of science) and on their self-esteem and self-efficacy (Black, 1998; Crooks, 1988; Gipps, 1994). McGinn and Roth (1998), for example, found two students used grades to construct themselves and each other as able (or in one case unable) to do and understand science and therefore as able (or unable) to pursue a career involving science. Similarly, classroom assessment influences students' ability and willingness to self assess (Boud, 1995; Crooks, 1988). These influences are worthy of careful attention as students who lack confidence may limit their learning and assessment opportunities to ensure they don't fail (Black, 1998; Boud, 1995; Loughran & Northfield, 1996).

Another effect of assessment, especially summative assessment, is that it evokes strong feelings. These are often negative and reinforced over time so that some students come to fear tests as occasions for the public display of failure (Deyhle, 1983; Shields, 1997). Feelings are important when learning is viewed as requiring active engagement, effort, persistence and to involve risks (Boud, 1995; Carr et al., 1994; Pratt, 1994; Raven, 1992).

In the social milieu of the classroom, assessment also plays an active role in the social construction of students as competent (Crooks, 1988; Clarke, 1996). Hanson (1993) argued that summative test results accumulate to "invent" individuals as social beings in that they create a social image that is used by others, and also the person concerned, as a predictor of their future. In a classroom, teacher and peer feedback may serve this function on a daily basis.

Students are “labelled” as being of high or low ability; of being bright or dumb (Bird, 1994; Broadfoot, 1996b, Delamont, 1983; Pollard, 1994; Rowntree, 1977; Woods, 1990). While these labels may initially be based on inconclusive evidence, they can become self-fulfilling and affect students’ learning and assessment opportunities (Filer, 1995; Newman, Cole & Griffith, 1989). Students have been found to act to maintain and enhance their identities, particularly when academic performance is publicly assessed. Furthermore, relationships are often influenced by classroom assessment (Blenkin, 1992; Crooks, 1988; Stiggins, 1991). For instance, student-teacher relationships often vary along the lines of students’ grades - those who are succeeding approve of what is happening. Jervis (1991) found that the fear of failure and competitiveness evoked by the prospect of state mandated tests disrupted the supportive relationships he had carefully built up (See also Harris, 1994).

Alongside this, classroom assessment is known to influence what comes to be valued and how knowledge is construed in a classroom. Recent research and development in assessment reflects a recognition of and concern about this effect (Black, 1993; Gipps, 1994; Gitomer & Duschl, 1997). Poole (1994), for instance, found the system of pre-tests, testing and test review employed by two history teachers encouraged a view of knowledge as objective and consisting of discrete, measurable units of information with an associated epistemological view of “knowledge as puzzles” with assessment as a “guessing game” (p. 127). This influence is special interest in science education where student understanding of the nature of science is a valued learning outcome (Ministry of Education, 1993b). However, the impact of formative assessment on how knowledge is construed is unknown.

The complexity of the relationship between teachers, students and learning that is involved and invoked by assessment is also evident in recommendations for and research on effective feedback. It is suggested that feedback needs to make a distinction between the person who is always valued and particular acts or work, which may be subject to critical comment (Boulet, Simard & Demelo, 1990; Boud, 1995; Cameron & Pierce, 1994; Kluger & DeNisi, 1996); distinguish between effort and evolving understanding (Boud, 1995); call attention to student accomplishments in themselves rather than their role in pleasing the teacher

(Good & Brophy, 1997); and help students to identify what they know, and understand (Biggs, 1995; Clarke, 1995; Radnor, 1994; Raven, 1992).

Research suggests that feedback that is provided before students have time to think through their own ideas or that simply confirms students' ideas are correct without explaining why does not enhance understanding or encourage students to think through their ideas (Woodruff & Meyer, 1997). It is suggested that feedback only enhances learning if received mindfully (Bangert-Downs, Kulik, Kulik & Morgan, 1991; Zessoules & Gardner, 1991).

Research on student utilisation of feedback further highlights the complexity of the interaction between formative assessment and student action. Kluger and DeNisi (1996), in an extensive review of the effects of feedback on performance, identified four broad categories of response to feedback. Individuals attempted to reach the standard or reference level (a typical response when the goal was clear, the individual had a high commitment to achieving the goal and his or her belief in eventual success is high); they abandoned the standard completely (this was common where the individual's belief in eventual success is low); changed the standard; and denied there was a gap. In terms of the learning of science, Chinn and Brewer (1993) found students with strong commitments responded to anomalous data in several ways, for example, ignoring it, rejecting it, judging it irrelevant and holding it separate from their views, or reinterpreting the data (see also Butler & Winne, 1995).

Student beliefs about learning are known to influence their perception and use of feedback (Butler & Winne, 1995). For example, Brown and Knight (1994) found that students with shallow learning approaches preferred feedback that indicated how to complete tasks, rather than feedback that challenged them to deepen their understanding. In the context of secondary and post secondary education, Schommer (1990, 1993) found that students considered learning should not require a lot of effort, should happen quickly and be "simple" in the sense that knowledge should be unambiguous with one right answer. The impact of this on what students perceive and use as effective feedback is unknown. Presumably, students who believe learning involves effort would respond to feedback that suggests understanding is possible given sufficient effort, whereas those who

believe learning should be simple may prefer feedback that indicates whether an answer is right.

To summarise, formative assessment can enhance learning but it seems that classroom assessment affects student priorities and lives beyond the provision of information on what has and has not been learned to exert a significant influence on the nature and quality of their educational experiences. Assessment with a formative intent may not have a formative effect. Like students' other classroom experiences it seems that formative assessment has cognitive, emotional and relationship effects and meanings (Erickson & Schultz, 1992). These wider influences are under researched but Raven's (1992) assertion that it does not make sense to assess abilities except in relation to valued goals also seems pertinent in any consideration of the nature and effects of formative assessment (see also Berlak, 1992). However, what is unclear in most of the research reviewed here is whether the emotional and relational effects of assessment are of concern because they might undermine the learning process or because they are seen as integral to learning and what is learned. Black and Wiliam (1998a), for instance, in their review of formative assessment, restricted their selection of studies to those that showed qualitative gains in academic achievement, thereby excluding as valued learning outcomes a consideration of motivation to learn, persistence and willingness to self assess.

(d) Summary of students and formative assessment

Student involvement in formative assessment seems essential and their perspectives provide an insight into how and why it might (or might not) be accomplished in practice. Research on student goals, disclosure, their use of feedback and the effects of formative assessment on them indicates that formative assessment is experienced as more than a technical process. Formative assessment has emotional, social and cognitive effects that form interrelated experiences for students. However, not enough is known about the actual impact of different assessment practices on students and their learning (Pollard, Broadfoot, Croll, Osborn & Abott, 1994; Tunstall & Gipps, 1995) particularly in the context of everyday classroom interactions (Torrance & Pryor, 1995).

(ii) Teachers and formative assessment

To a large extent teachers circumscribe the actions and interactions that are possible and valued in a classroom. To this end, Black (1998) ascribes the central role in formative assessment to the teacher (p. 104). Thus formative assessment in the classroom is influenced by the teacher's practice, including the teacher's assessment practice.

(a) The nature of current teacher formative assessment practice

Much of the research on teachers' everyday classroom assessment practices is critical. Research suggests that teachers (a) "target" only a few students (Tobin & Gallagher, 1987), (b) confuse learning with a range of student responses such as task engagement and completion, and degree of enjoyment, attention, persistence and confidence in speaking that is exhibited (Bell & Pearson, 1992; Bell & Gilbert, 1996; Cooper & McIntyre, 1996; Jackson, 1968; Perrenoud, 1991; Reynolds, Martin & Groulx, 1995), (c) direct most of their actions towards the progress of the class through the curriculum rather than identifying individual understanding (Bachor & Anderson, 1994; Savage & Desforges, 1995), (d) overemphasise grading (Anders & Richardson, 1994; Black & Wiliam, 1998a; Crooks, 1988; Daws & Singh, 1996), (e) make norm rather than criterion referenced judgements (Black & Wiliam, 1998a; Crooks, 1988; Daws & Singh, 1996; Dassa, Vazquez-Abad & Ajar, 1993; Torrance & Pryor, 1995) and (f) encourage superficial and rote learning (Black & Wiliam, 1998a). It seems that even when teachers identify differences in student understanding they do not necessarily make a distinction between the students in their planning or interactions (Bennet, Desforges, Cockburn & Wilkinson, 1984; Savage & Desforges, 1995).

Further, teachers tend to provide simultaneous feedback for learning, evaluation, motivation and social control (Broadfoot, 1996a; Mavromattis, 1997; Newman, Griffin & Cole, 1989; Torrance & Pryor, 1998). Concern was expressed by Pryor and Torrance (1996) that, in some instances, feedback to maintain student self esteem is provided at the expense of feedback to enhance learning (see also Bennett & Kell, 1987). On the other hand, Pollard et al. (1994) substantiated the view that although teachers recognised the importance of formative assessment

they were also cognisant of need to take account of their students' emotional needs.

(b) Teacher assessment practices are diverse and varied

The literature on teacher assessment practices indicates they tend to be quite varied (Airasian, 1994; Bachor & Anderson, 1994; Bright-Moore & Collins, 1998; Brookhart, 1997; Champagne & Newell, 1992; Duffee & Aikenhead, 1992; Gipps, Brown, McCallum & McAlister, 1995; Harrison, 1996; Hill, 1997; Johnston, Gruice, Baker, Malone & Michelson, 1995; Perrenoud, 1998; Stiggins & Conklin, 1992). Gipps, Brown, McCallum & McAlister (1995; 1996), working with British teachers of students aged 7 - 11 as they implemented Key Stage 1 and 2 teacher assessment, summarised these differences in teacher practice in terms of the dimensions of systematically, integration with teaching and ideological underpinning. They defined three models of teacher assessor: intuitives, evidence gatherers and systematic integrators. The teachers they labelled intuitives resisted the adoption of more formal assessment strategies and had either a "children's needs" view of curriculum, teaching and learning or considered their "tried and true" practices were satisfactory. Their assessment practices were characterised by a lack of observable ongoing teacher assessment and a reliance on memory for recording. The "evidence gatherers" believed in the primacy of teaching over assessing. Evidence gathering was associated with a belief that students learn what is taught and only what is taught. The teachers gathered evidence for later evaluation in ways that did not interfere with their teaching. Systematic planners made a closer link between assessment and instruction. They systematically planned assessment activities and although they upheld the centrality of teaching they also used assessment results to plan instruction, often in diagnostic ways. Bachor and Anderson (1994), working with primary teachers in British Columbia, and Hill (1997), working in New Zealand, have found similar patterns in teacher assessment practices.

Tunstall and Gipps (1996), on the basis of a study involving eight infant teachers and forty-nine students, distinguished between teacher feedback for socialisation and for assessment. They further differentiated feedback for assessment in terms of evaluative and descriptive feedback. Evaluative feedback was defined as norm referenced and usually either positive or negative in that it involved either reward

or punishment or approval or disapproval. It related to the conative or affective aspects of learning. In contrast, descriptive feedback was defined as either specifying attainment or improvement or as constructing achievement and the way forward. Tunstall and Gipps argued that descriptive feedback had a cognitive emphasis and was associated with formative assessment.

In terms of formative assessment in the context of everyday practice, Torrance and Pryor (1995) identified two forms of teacher assessment: convergent and divergent. Convergent assessment was defined as focused on finding out if a student knew a predetermined thing. It was associated with detailed planning, the systematic collection of data and the 'interpretation of the interaction of the child and the curriculum from the point of view of the curriculum' (Torrance & Pryor, 1995). Divergent assessment was defined as focused on finding out what students understood and analysed the interaction of the child and the curriculum from the point of view of the child. It was characterised by less detailed planning, open forms of recording and an intention to scaffold student learning. In their view, convergent assessment is associated with a behaviourist view of learning and divergent assessment is associated with a more constructivist view of learning (See section 2.3).

Differences in teacher practices are of interest in formative assessment because they have been found to affect assessment opportunities and student assessment. Filer (1993, 1995) found that assessment of a student's skills and abilities in speaking changed when the student changed from one teacher to another. She concluded that the variation could be attributed to the way the two teachers managed the social organisation of their classrooms and "framed" educational knowledge. Key factors in the teachers' social organisation were the extent to which the organisation of work was routinised, the amount of effort put into motivation and creating a positive classroom climate and the extent to which the teacher overtly used the expected power differential between teachers and students. The framing referred to:

The degree of control teacher and taught possess over selection, organisation and pacing of educational knowledge and the strength of the

boundary between what may or may not be transmitted in the pedagogic relationship as educational knowledge (Filer, 1995, p. 28).

Filer asserted that different frames provide different contexts for assessment because they set up situations in which it is possible and appropriate for students to disclose different aspects of what they know, feel, understand and can do. Thus understood, assessment may be viewed as a product of a teacher-created classroom environment; therefore, information about student learning may be seen to be contextualised by the teacher and the classroom.

Stiggins and Conklin (1992), on the basis of classroom research in America in the 1980's, concluded that students' assessment opportunities are influenced by a teacher "created" assessment environment. They found that the type of environment created depended not only on teacher assessment purposes and methodologies, the criterion for selection of tasks, and the quality of feedback, but also on the teacher's background, personal and behavioural characteristics and his or her perception of students, and the assessment-policy environment.

Similarly, Johnston, Gruice, Baker, Malone & Michelson (1995), concluded on the basis of an analysis of the literacy assessment practices of 25 teachers, that teacher assessment practices were motivated and sustained by systems of beliefs about teaching, learning and the domain being assessed, informed by their knowledge of the domain being assessed and framed by the school setting. In short, the teacher is an "interpretive mirror that provides constructs through which children represent their own performance" (Johnston, Gruice, Baker, Malone & Michelson, 1995, p. 369). Hence, it becomes important to study formative assessment in the context of individual classrooms (Perrenoud, 1998).

(c) Influences on teacher practice

Three significantly different explanations for the nature of teacher assessment practices are evident in current discussions of and research on teacher implementation of assessment policies and innovations. The first explanation is that (weak) teacher practice is influenced by limitations in teacher knowledge. For instance, it is suggested that teachers have had little training in assessment (Black & Wiliam, 1998a; Broadfoot, 1996b; Stiggins, 1991). Others have suggested that

teachers may lack both subject knowledge and the kind of understanding of the likely progression in student ideas needed to develop criteria for assessment (Bachor & Anderson, 1994; Jones, Moreland & Northover, 1999). This notion of teacher assessment is consonant with research on teacher knowledge (Schoenfeld, 1992; Shulman, 1987).

A second explanation is that teacher assessment practice, like their other practices, is influenced by their beliefs, values and visions of teaching and learning (Bell & Gilbert, 1996; Duffee & Aikenhead, 1992; Gipps, Brown, McCallum & McAlister, 1995; Paechter, 1995; Murphy, 1995; Tittle, 1994). Briscoe (1993), for instance, found a chemistry teacher's attempts to change his assessment practice were constrained by his view of the classroom as a work place with an associated view of assessment as giving out rewards and punishments to ensure students completed their work (pay for work) and were provided with information to revise their views. Teachers' reported concerns about the conflict between externally imposed systems of assessment for accountability and their view of how they should relate to students highlights the relationships between their perception of their responsibilities and their assessment practices (Anders & Richardson, 1994; Firestone, 1998; Hattie & Jaeger, 1998; Jervis, 1991; Paechter, 1995; Wiliam, 1995).

The third explanation for the nature of teacher assessment practice is that teaching, and hence assessment, involves uncertainties, challenges and dilemmas (Ball, 1990; Gallas, 1995; Lampert, 1990; Lyons, 1990; Roseberry & Puttick, 1998). In this explanation, teacher practice is considered shaped by the classroom. For instance, teacher action may be constrained by curriculum requirements (Gipps, 1994; Lemke, 1990; Torrance, 1992) and also by their ongoing responsibilities for the learning and behaviour of the class, as well as for developing individual understanding (Torrance, 1993). In addition, Wolf and Gearhart (1997) noted that teachers also need to balance helping students feel comfortable with new ideas with challenging them to reflect on and extend their accomplishments. Seen this way, assessment lies at the point of confluence of teacher responsibilities for the students in their care, and teachers' assessment practices usually reflect this (Drummond, 1993). It is interesting to note that research that presents a more positive view of teacher assessment practice has

generally been informed by a constructivist view of learning (Pollard, Broadfoot, Croll, Osborn & Abbott, 1994; Torrance & Pryor, 1995; Tunstall & Gipps, 1995)

Johnston, Gruice, Baker, Malone and Michelson (1995) sum up the multiple influences on teacher assessment practices succinctly. In their words:

In the end, assessment is always more social than technical. It involves complex, often conflicting, personal and institutional belief systems that are embedded in interpersonal relationships. (p. 370)

It appears that what is both lacking and needed in the discussion of teacher formative assessment practices is a view of teaching as learning about students and student learning. Such a perspective could provide a framework for describing and explaining teacher assessment actions in terms of their knowledge and beliefs about the goals of education, their responsibilities to their students and also in terms of the social context of classrooms.

To summarise, the literature indicates that teacher assessment practices are varied so that formative assessment needs to be studied at the level of the classroom. Moreover, it seems teacher practices are motivated and sustained by systems of beliefs about teaching, learning and the domain being assessed, they are informed by teacher knowledge of the domain being assessed, and are framed by the school setting. Thus understood, any view of formative assessment needs to consider teachers as active participants in the process (Tittle, 1994).

(iii) Classroom interaction and formative assessment

The influence on formative assessment of the classroom and the special nature of classroom interactions is another aspect of the practice of formative assessment that has received very little attention (Torrance & Pryor, 1995, 1998). This section examines and frames this influence in terms of those of the roles and responsibilities of teachers and students, the continuity of teacher-student relationships and the uniqueness of each classroom context.

(a) Student and teacher roles and responsibilities and formative assessment

In the current discussion of classrooms, some argue that teacher and student roles and responsibilities are mutually and reciprocally constituted. One perspective on the mutual constitution of teacher and student roles is that they are based on a “didactic contract”, that is, a network of largely implicit expectations and obligations that evolves between teachers and students and then constrains their actions (Brousseau, 1984), including those related to assessment (Perrenoud, 1991; Clarke, 1995). The common classroom pattern of known-answer teacher question, student response and teacher evaluation clearly illustrates how classroom assessment serves to mutually construct teacher and student roles (Edwards & Mercer, 1987; Edwards & Westgate, 1987; Filer, 1993,1995; Lemke, 1990; Mehan, 1979; Radnor, 1994). This practice, which contrasts with the everyday purposes for questioning, positions teachers as people with the authority to decide if and when a student makes a contribution, and if their contribution is legitimate (Filer, 1993,1995; Radnor, 1994). In this setting, being a learner is also about being a student (Ferne, 1988; Fernie, Davies, Kantor & McMurray, 1993; Fernie, Kantor, & Klein, 1988; Harter, 1996; Willes, 1983). This action not only communicates information about content but it also serves as a medium for maintaining and negotiating social relationships (see Barnes, 1976; Bowers & Flinders, 1991; Resnick, 1991) and this questioning sequence continually constitutes students as lacking power (Fairclough, 1992). In this setting, students have been found to respond to the question they consider implicit in the context rather than what the teacher actually asked (Donaldson, 1978) and to elaborate on their answers when teachers ask fewer questions (Carslen, 1991a; Wood & Wood, 1983). Thus understood, teacher assessment is not simply a process of eliciting evidence of student learning.

The importance of teacher and student perceptions of roles has been highlighted by research on the implementation of new assessment approaches. The establishment of an assessment culture to support the use of assessment as a moment of learning has been found to require a “complicated reevaluation of classroom activities and responsibilities” (Zessoules & Gardner, 1991, p. 63), something which teachers and students often find difficult. Radnor (1994), for example, found that teachers had difficulty implementing the notion of an “assessment conversation” as a way of gaining insight into student perspectives in

the assessment of creative art work because their perceptions of teacher-student relationships, attitudes to their role as assessor, and approaches to what counted as knowledge within the classroom led them to dominate the conversations. Other researchers have found teachers needed to reconceptualise their roles in order to change their assessment practices (Briscoe, 1993).

It needs to be pointed out that students are not simply “acted on” by teachers. Students have been found to shape teacher actions by playing on the teachers’ need to maintain and sustain supportive relationships with them (Delamont, 1983; Descombe, 1995; Feiman-Nemser & Floden, 1986). They may resist a teacher’s efforts to change their practices (Cazden, 1993; Baird & Northfield, 1992; Litowitz, 1993; Loughran & Northfield, 1996; Thomas, 1999) and act to encourage the teacher to reduce the ambiguity and risks involved in engaging in tasks (Doyle, 1983). In terms of teacher assessment, Torrance and Pryor (1998) provided a detailed analysis of how a new entrant student resisted her teacher’s attempts to socialise her into the role of a student during the teacher’s initial assessment of the student. Parkin and Richards (1995) and Fairbrother (1995) found it took time for students to reconceptualise their role in the teaching and learning process when they implemented a system of self-assessment. As current views of learning construe learners as active within the learning process, there is a need to investigate how and if students act to shape or resist ongoing teacher formative assessment. This investigation is made more important because teacher and student expectations and obligations are often determined and then articulated through assessment (Broadfoot, 1996a; Clarke, 1995; Perrenoud, 1991).

The language of the subject of study also needs to be considered in any discussion of teacher and student roles and the nature of formative assessment (Torrance & Pryor, 1995). Lemke (1990) not only argued that learning science was consonant with learning to talk science he also pointed out that the power inherent in the role of teacher is supplemented by their ability to use the language associated with a subject. This ability positions them as “someone who knows”. Lemke (1990) also found students who are able to use the language of science were constructed as knowledgeable. Thus, as Bowers and Flinders (1991) noted, “language serves to communicate information and, at the same time, as the medium for maintaining

and negotiating social relationships” (p. 21; see also Resnick, 1991; Barnes, 1976).

Combined, the aspects of the special nature of classroom interactions, the nature of teacher and student roles and relationships and the role of language indicate that formative assessment will involve more than the exchange of unambiguous information about student learning (Torrance & Pryor, 1995).

(b) Continuity of relationships

A second dimension of the classroom as a context for formative interactions is the continuity of teacher - student relationships. As Mercer (1995) noted: “all conversations have a history and a future and take place between particular people in a specific place and time. Talk is always ‘situated’” (p. 30). In terms of formative assessment, what students learn from one assessment is not interpreted in isolation. The messages about what is considered important to learn and how to learn are interpreted in context. In Boud’s (1995) words:

Students are not simply responding to the given subject - they carry with them the totality of their experiences of learning and being assessed and this certainly extends far beyond concurrent and immediately preceding subjects. (p. 37)

Moreover, teachers and students have not only a shared past but a shared future and the future they anticipate influences their actions. This continuity of relationships contributes to the risk of disclosure and to long term effects stemming from formative assessment. For instance, teacher expectations may become self-fulfilling and then inhibit (or enhance) student learning.

(c) Each classroom is unique

A third dimension of the classroom context for formative interactions is that each classroom is unique. In each classroom, teachers and students negotiate what it means to be a student, how knowledge is construed and what counts as knowledge (Blumenfeld & Mergendoller, 1992; Chandler, 1992; Collins & Green, 1992; Moje, 1995; Weade, 1992). Lytle and Cochran-Smith (1992) proposed that teachers and students, regardless of how they view teaching and learning,

inevitably negotiate what counts as knowledge in the classroom, who can have knowledge, and how knowledge can be generated, challenged and evaluated.

Lampert (1986) proposed that whether the students saw themselves as “sense makers” and problem solvers, or alternatively as “rememberers and forgetters” was socially negotiated and this influenced whether students considered they could contribute their own ideas (Marshall, 1992). Whether students construe themselves as sense makers is important when student self-assessment is considered to be an important part of formative assessment. Moreover, the two roles identified by Lampert are similar to the student goals identified by Dweck (1986) adding credence to the view that this distinction is significant.

The existence of situated definitions for what counts as a “good” student, school science, and doing and understanding science is of interest in formative assessment because what people prescribe as effective behaviour or competence is determined by their perceptions of their society, how it works and their role in it (Raven, 1992, p. 54). Raven proposed that successful performance depends on affective aspects like anticipating success and expending effort, support from others, believing one’s behaviour is consistent with one’s own and others’ view of what is appropriate, and cognitive factors such as thinking and planning ahead. Formative assessment seeks to determine what students can and cannot understand and do, with the intention of using this information to enhance learning. Hence, perceptions of competence and what it is appropriate to do and say shape teacher and student opportunities and goals for formative assessment.

In the end, however, the context for interaction exists in the moment. It emerges from the interactions among the participants (students and /or teachers) in a particular social and material setting (Edwards & Mercer, 1987; Kelly, Chen & Crawford, 1998). It is shaped by the time of day, the mood of the students and the teacher, events from previous lessons (Loughran & Northfield, 1996) and teacher and student intentions at time. Thus understood, the contexts for formative assessment are unique and unrepeatable.

Summary of the nature of formative assessment

A review of the literature revealed a number of debates about how formative assessment might be accomplished in practice. These points of contention indicate that formative assessment can not be conceptualised as an activity that proceeds in a simple manner and gives rise to a simple outcome. Taken together, the literature indicates students are active participants in classroom activities, it indicates that task engagement, learning and formative assessment have social, relational, emotional and cognitive aspects. The reviewed literature also drew attention to the challenges to and social nature of teacher formative assessment and to the influence of context. These aspects are construed by some as side effects to be monitored and by others as integral to the process. At this stage no account has been given of how they might be accounted for. The relevance of the aspects depends on how learning and hence formative assessment is theorised because this effects the nature of the relationship between the learner, teacher and knowledge (and its uses in a social context). This is explored in the next section.

2.3 Perspectives on learning and formative assessment

Views about learning and knowledge are central to any discussion of formative assessment since they influence what it means to learn, know and understand, and accordingly how we theorise formative assessment (Blackmore, 1988; Galbraith, 1993; Gipps, 1994; Shymansky & Kyle, 1992; Torrance, 1993).

For the purposes of this study, three views of learning based on three views of knowledge are distinguished and then a synthesis of sorts is proposed. The three views of learning are (i) behaviourist, based on an empiricist view of knowledge, (ii) cognitive-constructivist, based on a rationalist conception of knowledge, and (iii) socio-cultural, based on a sociohistoric view of knowledge (Case, 1996; Hand & Treagust, 1998). The behaviourist view of learning underpins traditional technicist summative assessment practices (Blackmore, 1988; Broadfoot, 1996a; Murphy & Torrance, 1988; Willis, 1994). Current definitions of formative assessment are consonant with both behaviourist and constructivist views of learning (Tunstall & Gipps, 1995; Torrance, 1993). Sociocultural views of learning are increasingly being used to explain teaching and learning (Hennessy & Murphy, 1999; Roth, 1995a) and assessment (Gipps, 1999) in the classroom.

These views and their implications are outlined in this section to argue that a view of learning as a transaction between the sociocultural setting and individual constructive activity provides the most useful means for describing and theorising formative assessment in (science) classrooms.

2.3.1 The behaviourist view of learning

The behaviourist perspective, which views knowledge as an objective absolute, has dominated teaching for many years, and also research until at least the 1970's. Learning is construed as the process of acquiring and storing that knowledge. The teacher's task is one of breaking down the knowledge hierarchy into discrete packages and transmitting these to a student. In the process, the students' prior knowledge is usually ignored (Case, 1996) because the brain is seen as an empty vessel waiting to be filled. No account is given of cognition, that is, what is happening inside the head.

Formative assessment consonant with this view is an activity teachers, not students, engage in to determine whether students have acquired the delivered knowledge (Murphy & Torrance, 1988; Willis, 1994) and to provide students with feedback about whether they are right. More practice is demanded if they are not (Gallagher, 1993; Meltzer & Reid, 1994; Sadler, 1989; Torrance, 1993; White, 1992). In other words, assessment simply aims to test students' ability to reproduce content (Murphy & Torrance, 1988; Willis, 1994). This perspective, and the widely used "technicist" model of assessment that accompanies it (Blackmore, 1988; Murphy & Torrance, 1988; Willis, 1994), is based on the assumption that assessment is a neutral activity able to make precise objective judgements about individuals whose intelligence is assumed to be a stable, unitary, limited, personal capacity (Blackmore, 1988; Case, 1996).

From this perspective, issues to do with the nature of interpretation and the nature and influence of students' response to feedback do not arise. However, the assumptions underlying this perspective are highly problematic. It should be noted that criticisms of this approach are that (i) it fails to do justice to the uniqueness of people, (ii) by focusing on observable behaviours many important practical, social and personal attributes are ignored, (iii) it fragments knowledge,

and (iv) the focus on extrinsic motivation through rewards undermines intrinsic motivation, student autonomy and conation.

2.3.2 The cognitive-constructivist view of learning

In direct contrast to behaviourism, a cognitive-constructivist view of learning postulates that knowledge is a mental representation that is actively build up by the learner as part of the process of making sense of the world (Driver, 1989a; Duit, 1994; Osborne & Wittrock, 1985; Osborne & Freyberg, 1985; Wheatley, 1992). Previous knowledge is considered to both enable and constrain individual meaning making (Resnick, 1991). Learning is seen as an active, intentional, individual and somewhat idiosyncratic process (Salomon, 1998). Thus understood, student involvement in formative assessment is vital and student self-assessment a desired goal.

As viewed from a cognitive-constructivist perspective, formative assessment is integral to effective teaching, given that teaching and learning are considered to be not directly linked (Nuthall, 1997). It is the means of obtaining information about the learner's prior conceptions as a prelude to teaching, and of gathering information on the diverse change and development in each learner's conceptions during the process of learning (Blackmore, 1988; Carr et al, 1994; Clarke, 1992; Gunstone, 1994; Tobin, 1993; White, 1992). Rather than the focus being on student deficiencies it is on students' current understandings (Blackmore, 1988; Clarke, 1995; Dassa, Vazquez-Abad & Ajar, 1993; Meltzer & Reid, 1994; Torrance, 1993) and their learning strategies (Willis, 1994). Furthermore, students must be provided with opportunities to disclose and demonstrate what they know. Students' ideas are viewed as sensible to them, consequently the challenge for teachers is to understand these (Brown & Knight, 1994) and stimulate students to question and reconsider their ideas (Fensham, 1994; Osborne & Wittrock, 1985; Osborne & Freyberg, 1985). An important question for teachers is how to do this without undermining the student's own sense making. Research indicates that students who see teachers as authoritative try to determine what the teacher thinks is right, or wants them to learn, rather than engaging thoughtfully in activities (Ball, 1993; Cobb, 1994; Edwards & Mercer, 1987; Gee, 1996; Nuthall, 1997; Wood, Cobb & Yackell, 1995). The teacher's role includes

helping students to recognise and share their purposes for engaging in a learning activity and their criteria for quality (Sadler, 1989). Decisions about the most efficacious time and way to intervene are further complicated because the teacher needs to balance the needs of each individual, which are expected to be diverse, with those of the class (Osborne, 1997). In addition, teachers legitimate some ideas and not others and so formative assessment is a significant factor in the acculturation of students (Clarke, 1992; Tanner & Jones, 1994; Yackell, Cobb & Wood, 1992).

Adding to the complexity of formative assessment from this perspective, research indicates that the knowledge and beliefs of peers hold a privileged position in influencing students to reconsider their ideas (Hennessy & Murphy, 1999; Nuthall, 1997). Friends are particularly influential (Davies, 1984; Cullingford & Morrison, 1997; Jackson, 1968; Zajac & Hartup, 1997). Peer involvement, while it may make formative assessment more manageable for the teacher, may not always foster the intended learning (Rogoff, 1991).

Seen this way, formative assessment forms a dynamic interaction between teaching and learning, and continuously informs it (Clarke, 1996; Gipps, 1994; Meltzer & Reid, 1994). As Clarke (1996) says, teaching, learning and assessment are “symbiotic”; with assessment being the means of mutual feedback and dialogue (Boud, 1995; Clarke, 1995; Filer, 1995; Sadler, 1989; Torrance & Pryor, 1995; Tunstall & Gipps, 1995). Teachers learn about their students and their own teaching (Darling-Hammond, 1994; Driver, 1995) and students learn about the viability of their ideas.

Many of the recommendations for formative assessment (Section 2.2.3) arise from this perspective. For instance, the development of effective assessment tasks is a priority when knowledge is viewed as located inside the brain (Eisner, 1993). Self-assessment is essential when learning is viewed as an individual rational activity. This view provides an explanation for the diversity of student understandings revealed by formative assessment (Bennett et al, 1984; Black 1993; Blenkin, 1992; Dassa, Vazquez-Abad & Ajar, 1993; Kelly, 1992; Savage & Desforges, 1995; Perrenoud, 1991; Torrance, 1993). Seen this way, interpreting the actions of others requires the development of viable explanations which may

then be tested for a “fit” not a “match” (Von Glaserfeld, 1989; see also Cobern, 1993). Murphy (1995) argued that for teachers what is considered a fit depends on their experiences of and beliefs about students and their own understandings of science and what it means to know and understand science (see also Black & Wiliam, 1998a). She proposed that fit for students would depend on the meanings they attributed to teacher actions and words and to the activities they engaged in. She suggested these would depend to an extent on their understanding of school and assessment practices (Murphy, 1995, p. 252). Thus, this view draws attention to the variation in and relationship between teacher and student assessment practices and their existing views of “self, of teaching and learning and of the curriculum, broadly speaking” (Tittle, 1994, p. 151). However, criticisms of this individual cognitive - constructivist perspective are that it does not pay sufficient attention to the affective and social aspects of learning (Driver, 1993; Pintrich, Marx, & Boil, 1993; Solomon, 1987; White, 1992), that it separates action from cognition and that it pays insufficient attention to power issues, especially those related to knowledge (Delpit, 1988; O’Loughlin, 1992). Such criticisms point to research that indicates human performance is highly context dependent (Lave, 1988).

2.3.3 Social views of learning and formative assessment

In this thesis, it is argued that learning can be viewed as a social practice. Such a view is built on a constructivist view of learning (Resnick, 1991) and is increasingly being applied by educational researchers endeavouring to understand and enhance teaching and learning in classrooms (Brown, Ash, Rutherford, Nakagawa, Gordon & Campione, 1993, Bruner, 1986, 1990, 1996; Cobb, 1994; Hennessy & Murphy, 1999; Pollard, 1996; Resnick, 1991; Roth, 1995a; Salomon & Perkins, 1998; Shweder & Sullivan, 1993; Scott, 1998, 1999), including science classrooms (Roth, 1995a, 1995b; Scott, 1998, 1999). It is consonant with current research that suggests scientists working in laboratories construct knowledge through discursive practices such as posing questions, sharing ideas, assessing alternatives, weighing evidence and evaluating the viability of differing theories using the tools available to them (Driver & Newton, 1997). This section outlines this view and theorises its implications for formative assessment.

The origin of most social views of learning may be traced to Vygotsky's proposal that learners have access to higher mental functions, such as scientific concepts, only through processes that originate in social activity (Vygotsky, 1986; see also Cole, 1991; Howe, 1996; Mercer, 1995; Nuthall, 1997; Resnick 1991; Rogoff, 1990, 1995, 1997; Wertsch, 1991). According to Vygotsky, it is not only important to examine the child and his or her interactions with the physical world (as constructivists argue) but also the immediate social world in which the child is located and the nature of the interactions that take place within it. Seen this way, concepts are considered to be first rehearsed between people prior to being internalised and developed within the learner as an intrapersonal function. On the interpersonal plane, language and tools are considered to be used in the development of meanings between individuals and this language then provides the means that mediate individual meaning making. Moreover, as Vygotsky points out, the learners do not simply translate the concepts to the intrapersonal plane but transform, reorganise and reconstruct their experiences (Howe, 1996) through the mediation of language (Wertsch, 1991; Wertsch & Toma, 1995). In this view, it is not sensible to separate the emotional, conative and cognitive aspects of learning.

The practical implications of Vygotsky's view are embodied in the notion of a zone of proximal development. He defined this as the difference between the level of problem solving children could achieve by themselves and the level that could be accomplished with the help of an adult or more capable peer (Vygotsky, 1986, p. 86). The implication of this is that help from others is a natural part of human mental development (Mercer, 1994; Hennessy & Murphy, 1999). Conceptualised this way, active teacher and student involvement in formative assessment is essential. However, information is sought as a starting point for further learning not as something to be challenged as in the cognitive constructivist perspective (Howe, 1996). The purpose and focus of assessment is to find out what the learner could achieve next (Brown, Campione, Webber & McGilly, 1992) and to scaffold them towards this (Bruner, 1985).

Researchers building on Vygotsky's work have developed a variety of views of learning as a social process. Salomon and Perkins (1998), arguing the case for "social learning", distinguished six meanings of "social". Two of these meanings, learning as socially mediated individual learning and social processes

as cognitions, underpin this section (See also Rogoff, 1998). In the first case, interactions are considered to support learning. An example would be peers tutoring each other or working in groups (Alexopoulou & Driver, 1996). In the second sociocultural view of learning, social processes are viewed as cognitions (Resnick, 1991).

According to Wertsch (1991), the basic assumption of the sociocultural perspective is that “human mental functioning is inherently situated in social interactional, cultural, institutional and historical contexts” (p. 86). Seen this way:

it is unreasonable to separate cognition or motivation from the socially mediating context or, for that matter, to separate individuals from their activities and the contexts in which they take place” (Salomon & Perkins, 1998, p. 8/9).

Thus understood, meanings are not seen as exclusively the product of the person acting (Lave, 1988; Resnick, 1991; Salomon, 1993a, 1993b). Some theorists argue they are situated by virtue of being shared (Resnick, 1991). Others contend that they are distributed over people and materials (Cole, 1995; Greeno, 1997; Hatch & Gardner, 1993; Pea, 1993; Perkins, 1993; Resnick, 1991; Salomon, 1993a, 1993b). In this distributed view, the social and artefactual surrounds alleged to be outside the individuals’ heads are viewed as genuine parts of the learning. Still other theorists argue that meanings may be viewed as embedded in relational activities (Lave, 1988; Lave & Wenger, 1991; Rogoff, 1997). Within this perspective, people learn to act and interact within a social and physical environment and in the process move from being novices to experts in a certain community. Thus understood, learning involves changes in identity. Both the individual and the community are considered to change as a result of the individual’s participation (Lave & Wenger, 1991; Bruner, 1996). In another illustration of this view, Rogoff (1998) proposed that learning may be viewed as the “transformation of participation”. According to Rogoff (1990, p. 233) each community’s valued skills constitute the local goals of development and learning involves changes in roles and relationships. She too emphasises that the learner and the community change as a consequence of the learner’s participation.

Yet another view of learning as a social process is that it is a mediated action. Wertsch (1991) proposed that human action is always mediated in the sense that it is shaped (empowered and constrained) but not determined by the physical and psychological tools used and so it is a joint product of the person and the mediational means: hence it is a mediated action. An example of a mediated action is the pole vaulter's use of the pole vault - neither can be understood without reference to the other (Wertsch, 1995). In considering learning and development Wertsch focused on speech as the main mediational means.

What these various social views of learning bring to the fore is that any study of learning and consequently the formative assessment of it requires careful attention to (i) the institutional contexts of social interaction, (ii) "language" as a multitude of speech genres that are linked with particular institutions and social practices, (iii) educationally significant interactions as involving real people who develop a variety of interpersonal relationships with one another in the course of their shared activity in a given institutional context and (iv) modes of thinking evolving as an integral system of motives, goals, values and beliefs that are closely tied to concrete forms of social practice (Minick, Stone & Forman, 1993, p. 6).

This notion of learning implies it is inadequate to focus on behaviour or the internal representation of ideas as in the behaviourist and constructivist approaches. The situated social system becomes the focus of analysis (Greeno, 1997; Lave & Wenger, 1991; Newman, Griffin & Cole, 1989; Sfard, 1998; Salomon, 1997; Wertsch, 1991). Assessment activities may be considered to be negotiated by teachers and students (Newman, Griffin & Cole, 1989) and therefore to generate and embody information about both students and teachers in a manner similar to that proposed by Filer (1993, Section 2.2.3). Moreover, when knowledge and situations are considered to co-produce each other, as situated learning theorists contend (Brown, Collins, & Duguid, 1989; Hennessy, 1993), variation in student performance and represented achievement across and within tasks is expected (Moll & Greenberg, 1990; McGinn & Roth, 1998). Thus, this perspective provides a theoretical account of research that indicates minor changes in task presentation, context and mode of response produces significant variations in student responses (Filer, 1995; Murphy, 1995). It calls into question the push to develop new assessment strategies when this is underpinned by the

assumption that better assessment strategies will generate more reliable and valid assessment information. At the same time it raises questions about the impact of assessment strategies such as tests or those perceived as test-like on student participation in assessment interactions (Rogoff, 1998) given the long association between education and assessment for accountability (Section 2.3.3).

Another implication is that if people are considered to think in conjunction or partnership with others and with the help of culturally provided tools and implements (Salomon, 1993a) then a student's history notes, for example, are an integral part of what they know and should be viewed as such (Pea, 1993).

Furthermore, when learning is viewed as a relational activity the relationship between formative assessment and what it means to be an expert in a particular classroom, and how this evolves over time, becomes a consideration. What is learned in a classroom includes what it means to be a student (of science) in a particular classroom and what are the taken-as-valued scientific ways of acting and speaking in that classroom. The social meanings students have for classroom activities, for example, whether activities are perceived as a threat, a chore or linked with developing understanding, are of interest (Salomon, 1998). Methods of teacher formative assessment are not only means for eliciting information; they are also practices in which students learn to participate. Through these practices students develop patterns of participation that construct their identities as students and learners and include the ways they take initiative and responsibilities for their learning and assessment and function actively in the formulation of goals and criteria for their success (Greeno, 1997, p. 9). In this case, differences in students' interpretations of tasks and in their performance do not represent deficits in the student but differences in the communities (peer groups and classrooms) in which they participate (Cobb & Bowers, 1999; Lave & Wenger, 1991; Roth & Bowen, 1995). Greeno (1997) argued that this means the focus of attention should be on the "practices in which individuals have learned to participate, rather than on knowledge that they have acquired" as in the behaviourist and constructivist perspectives (Greeno, 1997, p. 8).

Classroom researchers working from this perspective typically work to establish communities of learners, scholars, inquirers or validators of knowledge (Brown,

Ash, Rutherford, Nakagawa, Gordon & Campione, 1993; Cobb, Wood & Yackel, 1991; Roth, 1995a). However, they note that this approach poses the challenge to teachers of how to keep the “social contact with students ... as co-equal participants in a community of sharing ... [while] maintaining their accountability for student progress and to fellow scientists” (Brown, Ash, Rutherford, Nakagawa, Gordon & Campione, 1993, p. 217). This challenge, while similar to that identified for teachers working from a constructivist perspective, focuses on the maintenance of relationships in addition to sustaining students’ rational engagement.

Problematic to the application of learning as legitimate peripheral participation (Lave & Wenger, 1991), or the transformation of participation (Rogoff, 1997) in the school context, are the assumptions that students pursue learning goals consonant with those of moving from being a novice to an expert in the practice of school science. As Lave and Wenger (1991) pointed out, “there is no cultural identity encompassing the activity in which newcomers participate and no field of mature practice for what is being learned” in classrooms. They proposed that “exchange value replaces the use value of increasing participation” and this generates “in conflicts between learning to know and learning to display knowledge” (Lave & Wenger, 1991, p. 112). As noted in Section 2.2.3 students may not have learning as their main or indeed peripheral purpose for participation.

As opposed to a community of practice view of learning, a view of learning as mediated action more fully considers and accounts for the multiple intentions and meanings of students and teachers as actors in the interactional and activity setting called school. Wertsch (1991, 1995) emphasised the role of language as a mediational means using Bahktin’s notion of voice or “speaking consciousness” to highlight that meaning making takes place in a social milieu, uses social tools and is necessarily dialogical (see also O’Loughlin, 1992). In Bahktin’s words it raises questions of “Who is doing the talking?” (Wertsch, 1991, p. 51). Teacher and student perceptions of their respective roles and relationships will influence the knowledge they consider appropriate to draw on and disclose (Cobb, Wood & Yackell, 1991). This seemed to be the case, for example, when a group of high school physics students presented their findings to a group of younger children and then to their teacher (Crawford, Chen & Kelly, 1997). When the students

students presented their findings to the children they explained and linked ideas in more elaborated ways than they did when presenting their work to the teacher. Crawford et al. concluded the students assumed their teacher did not need this type of support to understand what they had to say. Similarly, Gallas (1994) found that peers influenced student presentations in “news” sessions because student talk had meanings and social functions associated with establishing and maintaining status, identity and membership within peer group culture in addition to meeting the teacher’s academic purposes.

A further important aspect of the notion of mediated action is that particular ways of speaking and acting come to be “privileged” or seen as “more appropriate and efficacious in a particular setting” (Wertsch, 1991, p.54). Wertsch argued that because people can draw on a number of “social languages” or “speech genres” it is necessary to understand why a particular voice or language is used in order to understand what they are saying. In schools “the speech genre of formal instruction” has been found to take precedence because teachers have the authority to privilege their preferred speech genre. Klaassen and Lijnse (1996) argued that in their study teachers interpreted student ideas as misconceptions because they were using different “languages”. They concluded that interpretation requires a “way of thinking with someone else rather than requiring the use of the scientific view as the sole norm”. In another study, Lemke (1990) found that talking appropriately in American science classrooms involved avoiding colloquial language, figurative language, and reference to individual human beings and their actions (p. 131-134). Thus understood, the type of discourse used by a teacher and the nature of the actions they privilege will influence student disclosure in a classroom because “to expose one’s voice in the presence of others with different power hierarchical positions can be problematic” (Rodriguez, 1998, p. 601).

Rodriguez contended that trust is required if dialogic conversation is to take place. By the same token, Stone (1993) argued trust is a necessary interpersonal quality of a “zone of proximal development”. Classroom researchers have confirmed that trust is important to open discussion (Loughran & Northfield, 1996) and student willingness to disclose their ideas by asking questions (Harter, 1996). Adding to this, Taylor (1996) argued that respect and goodwill are necessary “in any

relationship that involves disclosure of personally significant meaning-perspectives” (Taylor, 1996, p.168). Taylor drew on the work of feminist scholars to propose that development of an atmosphere of mutual trust and respect needs the support of an ethic of “care”. An ethic of care places relations with others as a primary concern (Belenky et al, 1986; Noddings, 1984, 1986, 1988, 1995 Gilligan, 1982). Care is a mutual process - teachers care for students and the subject and students care for each other (Noddings, 1984, 1986, 1995). Van Sickle and Spector (1996) found that caring science teachers build relationships and connections among and between students, teachers and science. The notion of care suggests that assessment should permit and encourage students and teachers to share and discuss ideas in ways that sustain their relationships with science and each other while simultaneously enhancing students’ science understandings.

Another dimension of the notion of mediated action, as proposed by Wertsch (1991), is that discourse may be univocal or dialogic. In univocal discourse it is assumed that speech has an authoritative literal meaning. An example is the traditional transmission model of teaching where it is assumed that teachers can convey knowledge to students who receive it intact. In contrast, dialogic discourse is concerned with generating new meanings. An example would be teacher discourse that encouraged students to contribute, explore and debate ideas that are then viewed as “thinking devices” (Bahktin, 1981, pp. 342-343 quoted in Scott, 1999; O’Loughlin; 1992). In practice, Scott (1998, 1999) and Mortimer (1998) found teachers of science moved between the dialogic and authoritative functions as they encouraged students to make meaning and at the same time mediated their understandings towards those of scientists. Both are consistent with educational goals (Wertsch & Toma, 1995). A problem arises only if the teacher’s authoritative voice is the only one that is heard. When this is the case students will not develop good habits such as questioning and making links (see also Linn & Burbules, 1993; O’Loughlin, 1992; Scott, 1999). This notion provides a way of examining teacher feedback. If formative assessment seeks to encourage students to become a community of scholars, then the provision of dialogic feedback would seem to be a requirement. However, whether students perceive this to be the case is not known at present.

Intention is an important element of a sociocultural view of learning and formative assessment, and considered important in this study. What distinguishes the sociocultural perspective from the cognitive constructivist view of learning is that student and teacher intentions (with respect to goals, motives and interests) are seen as part of the learning process and not just a source of support (Moll & Whitmore, 1993; Minick, Stone & Forman, 1993; Shweder, 1990). Moreover, they are not seen as individual attributes, but something influenced by and linked to the classroom goals for being a student, for learning and for doing science. Very little research has explored the influences of student intentions on their participation in classroom practices that they construe as assessment or formative assessment.

In review, social views of learning construe it as a situated, social, intentional, meaning-making process inextricably related to the practices in which learners participate and to the development of their identities, given that their roles and relationships with others are transformed through participation. When viewed from this perspective, many of the issues such as variations of student performance across contexts and the diversity and overlap between students' learning and social goals can be accounted for.

2.3.4 A rapprochement

It is increasingly argued that an individual versus social dichotomy is unhelpful when the intention is to describe a complex activity such as learning and teaching in a classroom (Billet, 1996; Case, 1996; Cobb, 1994; Forman, Minick & Stone, 1993; Duit & Treagust, 1998; Krishna & Whitson, 1997; Salomon, 1997; Salomon & Perkins, 1998; Sfard, 1998). In the current political and policy environment, teachers and schools are expected to be able to report on students' achievement and progress (Chapter 1) even though, as Perkins (1993) notes, the "person-plus" may be desirable for learning (p. 95). A view of learning to inform the study of formative assessment needs to acknowledge individual and social aspects of learning (Broadfoot, 1996a). The views of learning proposed by Salomon (1993a), Cobb (and his colleagues), Pollard (1990) and Rogoff (1995) accommodate both aspects.

Salomon (1993a) proposed and argued for learning to be viewed as an interactive-transaction between individual cognitive and situated distributed cognitions. He asserted that not all cognitions are or can be constantly distributed and that no theory that attempts to account for development and change over time can do so without reference to individual mental representations or their equivalent of learning (see also Damon, 1991). He proposed that the individual and social aspects of learning were in spiralling, dynamic, reciprocal interaction (Salomon, 1997; Salomon & Perkins, 1998). Thus understood, individuals are considered to retain their identity while reciprocally affecting and being affected by others. The “residue” of this social activity is what enters into later situations of distributed cognition (Salomon, 1993b, p. xviii).

Salomon’s view is generally consistent with that proposed by Cobb, Yackel & Wood (1992). They argued that “an account of a student’s mathematical learning in the classroom should consider development of both taken-as-shared communal meanings and practices and the individual student’s personal meanings and practices” (p. 18). Conceptualising learning in this way allows for an explicit focus on individual student reasoning but rather than treating it solely as an internal mental phenomena it is considered an act of participation in communal (science) practices (Cobb & Bowers, 1999). Seen this way, students actively manage and reorganise their ways of participating and in turn the practice of the community (class) through their participation.

A third perspective of learning that accommodates individual and social influence is that proposed by Pollard (1990). He points out that among the meanings generated by students are understandings of oneself or a sense of identity. He argues that it is possible to distinguish three domains of social factors that influence learning: the intra-individual, the inter-personal and the socio-historical. The intra-individual is concerned with the ways individuals experience and construct understandings, the inter-personal domain is that in which meanings are negotiated and through which cultural norms and social conventions are learned. The socio-historical domain addresses the wider context in which learning takes places, including its origins and the circumstances of the learner.

Rogoff (1995) provides a similar account of the different aspects of the social domain. She proposed that sociocultural activity can be observed and analysed along the three mutually influential and constituted planes of the community/institution, interpersonal and personal processes. She suggested that these constitute different grains of focus on the activity as a whole so that rather than viewing the activity as involving either one aspect or the other, each may be foregrounded in turn with the other two remaining in the background. The adoption of a three-way analysis meets the need for a multilevel analysis identified by Lave and Wenger (1991) with regard to school based processes, and the three adopted planes reflect those found in the work of Forman, Minick and Stone (1993) and Hicks (1996). Thus understood, teacher and student beliefs about their own roles and the general nature of science activity at school, beliefs about science and school science and individual science activity are considered along with how formative assessment affects and contributes to the classroom social norms and the socioscientific norms and practices that are negotiated in each classroom. The influence of the wider school and community are also considered.

2.3.5 Summary of views of learning and formative assessment

A view of learning as social process with three planes of activity underpins this study. Learning and the formative assessment of it are considered to be constituted by the classroom practices students and teachers participate in, contribute to and act to modify. At the same time, it is considered to involve the development of “residues” that are the equivalent of individual mental representations. It is these “residues” of social activity that enter later situations of distributed cognition (Salomon, 1993a, page, xviii; see also Cobb, Yackel & Wood, 1992). Practices and residues may be seen to mediate further participation.

A view of learning as involving individual *and* social aspects was adopted because individual constructivism, although it has helped explicate students’ views and ensured that they are considered within the learning process, has not proved fruitful in the development of strategies to change student ideas. According to Hennessy and Murphy (1999) a sociocultural approach to learning currently “offers most insight into the processes affecting, indeed determining

learning” in a classroom (p. 4). However, it has also been argued that both the individual and the social approaches tell only half the story (Cobb, 1994; Kirshner & Whitson, 1997) and for the study of formative assessment, particularly in the current climate of accountability, it is important that a theory of learning to inform the development of a theory of formative assessment is able to examine and explicate both the individual and the social aspects of learning. A view of learning that accommodates both individual and social aspects of learning is also able to provide a theoretical basis for many of the findings of research into both the practice of formative assessment and teacher, student and classroom interactions.

2.4 The research questions

Formative assessment is considered to be a valuable classroom practice but little is known of how it is accomplished by teachers and students as a part of their everyday interactions. It is increasingly being recognised that, as Black and Wiliam (1998a) contend, “assessment processes are, at heart, social processes, taking place in social settings, conducted by, on and for social actors” (p. 56) but student, and to a lesser extent teacher, voices are largely absent from debates on the nature and effect of formative assessment. At this stage, no comprehensive theory of formative assessment has been developed. The purpose of this study was to describe, account for and theorise formative assessment as perceived and experienced by teachers and students.

To this end, the research questions that guided the data generation are:

- Was formative assessment being used and, if so, what was the nature of this formative assessment and how was it perceived and experienced?
- What theorising can be used to describe and explain the formative assessment identified?

In the next chapter, Chapter 3, the methodology used to generate data on teacher and students’ practices and perceptions with respect to formative assessment is outlined.

3. Methodology

3.1 Introduction

This chapter sets out the research methodology for the study. Research methodologies define for the researcher what can be known about, how it is considered this might be known and how she might go about finding out what she believes can be known. The research methodology, determined by the ontological and epistemological assumptions and purposes of the study, is outlined in Section 3.2. Section 3.3 outlines the characteristics of the interpretive method chosen. Section 3.4 provides an overview of the research design and discusses how issues to do with the trustworthiness of interpretive inquiry were addressed. Section 3.5 summarises the main points of the chapter.

3.2 Methodological Paradigms for research

The purposes and questions of a study and the ontological and epistemological assumptions that underpin it determine decisions about research methodology. This is because these factors influence what counts as evidence, how values are perceived and the nature of the relationships between the knower and the known (Denzin & Lincoln, 1994; Schaller & Tobin, 1998). A case has already been made (Chapter 2) that classroom learning and the formative assessment of it may be usefully construed as a situated social activity. The research questions include a requirement that teacher and student formative assessment interactions are observed in their natural setting and that teacher and student meanings for these be attended to (Erickson, 1986; Walsh, Tobin & Graue, 1993). Hence, a research approach was needed that recognised that there is a relationship between the knower, the known and the context (Denzin & Lincoln, 1994; Smagorinsky, 1995).

An interpretivist research perspective provides this because it is assumed that people jointly construct meanings and actions and that these are the subject of continuous negotiation but influenced by the context (Denzin & Lincoln, 1994, p. 4). Actions are seen as “situated in a cultural setting, and in the mutually interacting intentional states of the participants” (Bruner, 1990, p. 19).

Interpretive research seeks to understand these actions from the actors' point of

view (Erickson, 1986; Denzin & Lincoln, 1994; Lather, 1992; Cohen & Manion, 1994; Miles & Huberman, 1994; Walsh, Tobin & Graue, 1993). That is, it seeks to understand the participants' intentions, motives and stated reasons (Robottom & Hart, 1993). The intention is to uncover and understand what lies behind a phenomenon about which little is known, to gain "novel and fresh slants on things about which quite a bit is already known" and to give the "intricate details" of phenomena (Strauss & Corbin, 1990, p. 19). Moreover, as very little was known about the shared understandings between teachers and students with regard to formative assessment (Broadfoot, 1996a; Torrance, 1993) a methodology that emphasised the need to seek and respond to patterns, rather than impose them, was required (Miles & Huberman, 1994).

Interpretive research is appropriate in educational settings where there is a similarity between the actions of researchers and teachers: both are concerned with the "specifics of local meaning and local action; that is the stuff of life in daily classroom practice" (Erickson, 1986, p. 156). This mutual focus means it is easier for the researcher to establish a sense of rapport with those involved in the research. The research has the potential to give voice and visibility to teachers and students (Walsh, Tobin & Gruae, 1993). It is accessible to teachers because it privileges their interpretations (Denscombe, 1995) and therefore it offers the opportunity to generate knowledge which is useful and interesting to other teachers (Bell & Cowie, 1999).

3.3 Interpretative research design

Interpretive research involves a process of deliberate inquiry (Erickson, 1986; Cohen & Manion, 1994; Jacobs, 1988; Miles & Huberman, 1994). It is conducted in natural settings and the researcher employs multiple, usually qualitative, data generation methods. Data generation and analysis are ongoing and interact in a hermeneutic cycle (Guba & Lincoln, 1989). This ensures the research process is flexible and responsive. For instance, the focus of inquiry and the methods used for data generation may change in response to the researcher's perceptions and understandings of events (Erickson, 1986; Oldfather & West, 1994). Tentative assertions are developed and serve to inform further data generation and analysis. They are compared with further data for confirmation, negation or modification

(Guba & Lincoln, 1989). Thus understood, the main considerations in planning and conducting interpretive research are multiple perspectives, multiple data generation methods, units of analysis, ethics and ways of ensuring trustworthy data generation and analysis (Bell & Cowie, 1999). Each of these is discussed in this section.

3.3.1 Multiple Perspectives

Within the interpretivist research perspective, people are seen as intentional participants in the activities of their communities. The perspectives of all participants are of interest (Erickson, 1986) as this allows the researcher “to take advantage of the interplay, or triangulation, of multiple perspectives both to enrich and validate the interpretation of data” (Nuthall & Alton-Lee, 1993, p. 801; see also Measor, 1985).

The researcher is viewed as a participant in the interpretative research process because they are directly involved in data generation (Guba & Lincoln, 1989; Miles & Huberman, 1994). Their beliefs and attitudes, their perceptions of what is relevant, both consciously known to them and unknown, influence data generation and analysis (Erickson, 1986; Kelly, Chen & Crawford, 1998; Cortazzi, 1993; Gitlin, 1990; Gruae & Walsh, 1995; Measor, 1985; Tobin & Tippins, 1993). Hence, reflexivity on the part of the researcher is essential because he or she needs to be “constantly self-conscious about her role, her interactions, and her theoretical and empirical material as it accumulates” (Delamont, 1992, p. 9; see also Smagorinsky, 1995).

Formative assessment as an activity involves both teachers and students and therefore the research needed to explore the meanings they created together. Attending to their perspectives not only enhances the ecological validity of the research (Bronfenbrenner, 1979) but, in the case of students, simultaneously provides a unique opportunity to make the “familiar strange” (Erickson, 1986; Delamont, 1992; Smith, 1995; Walsh, Tobin & Gruae, 1993).

3.3.2 Multiple data generation methods

In interpretive research, multiple data generation methods are used to increase the credibility of the data generated from multiple sources (Maykut & Morehouse,

1994; Measor, 1985). The methods used include participant observation and interviews. These methods are discussed next.

Interviews

In interpretive research, interview data is viewed as socially constructed rather than collected by the researcher (Erickson, 1986; Measor, 1985; Mishler, 1986; Smagorinsky, 1995; Tobin & Tippins 1993). Interviews can vary from being highly structured and controlled by the researcher (respondent interviews) to informal conversations whose focus and direction are controlled by the participants (informant interviews) (Powney & Watts, 1987). Respondent interviews carry the connotation that there is a set of questions to be asked and it is the researcher's issues that matter. They have the advantage that the interviewer's issues *are* addressed. Informant interviews provide more insight into the perceptions of the person interviewed (McGee-Brown, 1995; Powney & Watts, 1987). Informant interviews were used in this study because little was known about teacher and student perceptions of formative assessment. Thus understood, the interviews were conceptualised as conversations with a purpose (Maykut & Morehouse, 1994).

Individuals or groups may be interviewed. One-to-one interviews are easier to manage and can be kept relatively confidential. In contrast, group interviews are harder to manage and the participants may be influenced by each other's answers and the nature of their relationships (Graue & Walsh, 1995). However, group interviews provide more opportunities for interviewees to check out the researcher and to set the level and context of the interview. They are useful for exploring a topic for which little information is available (Maykut & Morehouse, 1994). Graue and Walsh (1995) proposed group interviews are useful for interviewing children who are used to working with friends and so interviews become more like conversations as they negotiate the meaning of the researcher's questions and build on each other's answers (Walsh, Tobin & Graue, 1993). This study used both individual and group interviews.

As a data generation means, interviews have the advantage that teachers and students have seen and heard interviews on the media and may have participated in parent / teacher / student interviews. The audio-tape technology used for

recording interviews is in common use (Smagorinsky, 1995). However, as Scheurich (1995) cautions that the “language out of which the questions are constructed is not bounded or stable; it is persistently slippery, unstable, and ambiguous from person to person, from situation to situation, from time to time”. It is suggested this issue may be a particular challenge in interviews with children because questions reveal the adults’ perceptions of adolescents and this may shape what the children say and do (Baker, 1983). Another issue associated with interviewing young people is that they may lack the language to make their thinking explicit (Fine & Sandstrom, 1988; Gallas, 1994; McGee-Brown, 1995; Pollard, Thiessen & Filer, 1997). In a school setting where the typical adult - adolescent relationship is that of teacher - student, Bakhtin’s (1986) question of “Who is doing the talking?” (Section 2.3) has implications for the interviewer who seeks to question and probe student responses. Some writers suggest this means it is important to ask genuine questions (Bell, 1995). Others, for example Baker (1983), Smith (1995) and Spradley (1979), argue that the key to good practice in interviewing young people is relying on them “to teach the interviewer the questions most important to ask” (Graue & Walsh, 1995, p. 146). Both these approaches were adopted in this study.

Another issue with the use of interviews to elicit teacher and student perceptions of classroom events is that they necessarily take place after the event (Mehan, 1974). They rely on the recall and reporting of events and on participants’ willingness and ability to provide authentic accounts of their thoughts and experiences (Cazden, 1986). Suggestions to increase the fidelity of data generated this way are to combine interviews with participant observation (Cooper & McIntyre, 1996; Measor, 1985) and to interview participants as soon as possible after the event starting with a very open-ended question (Cooper & McIntyre, 1996). This approach was used in this study.

Participant observation

In interpretative research, participant observation is a strategy used to explore the situated experiences of others. A researcher may act as a complete participant so that her purpose is a secret, as a complete observer so she is removed from those observed, as an observer-participant where her identity is known but she remains a relative stranger, or as a participant-observer where she becomes more closely

involved with the participants (Ball, 1985; Cohen & Manion, 1994; Spradley, 1980). However, an adult researcher in a school is always identifiable and so cannot completely disguise his or her presence. Ball (1985) proposed this means the key issue for a researcher interested in student perspectives is whether they are accepted, not whether they can “pass” as a student (see also Measor, 1985). The development of such a research relationships takes time and so research on student classroom experiences usually involves prolonged engagement in the classroom (see for example Alton-Lee, Nuthall, & Patrick, 1993; Ball, 1985; Bird, 1994; Jones, 1991). In this study, classes were observed for a whole unit, a period of between three and six weeks.

Participant observations must be recorded for later analysis. Possible techniques are video-taping, audio-taping and field notes. Video taping has the advantage that it records verbal and non-verbal aspect of interactions but the disadvantages that it is obtrusive and time must be spent familiarising participants with the presence of the camera (Torrance & Pryor, 1995). Moreover, the camera must be pointed at and so frames only part of the action (Bassegy, 1998). Video taping also raises ethical issues in terms of privacy (Cazden, 1986). Audio-taping is less intrusive. It allows the voices of participants to be recorded but who will wear the microphone(s) must still be decided before the event. Field notes are flexible and unobtrusive, something that is an advantage in exploratory research, but not every thing can be recorded. Field notes were used in this study because of their flexibility and unobtrusiveness and because the time frame of the study did not allow for video taping.

In review, interpretive research uses multiple research methods to add to the richness and fidelity of the data generated by multiple sources.

3.3.3 Ethics

Ethical considerations are intrinsic to interpretive research (Erickson, 1986, 1998). When data are viewed as socially constructed, ethics are entangled with questions of epistemology because each decision about “what counts” involves a choice about engaging with and valuing a perspective (Clark & Moss, 1996). Ethical considerations are important because the meanings that are constructed arise out of the trust and rapport that develops between the research participants (Ball,

1985; Delamont, 1992; Measor, 1985; Walsh, Tobin & Graue, 1993). The researcher, who uses strategies to foster trusting relationships, has a responsibility to care for participants and ensure they and their community are not placed in a situation of potential harm by what might be done or disclosed as part of the research (Graue & Walsh, 1995; Noddings, 1995). Informed consent, confidentiality and protection from harm are subject to scrutiny and negotiated throughout the research as the design of the research and the relationships between the participants and the nature of their understandings and feelings develop and change (Brickhouse, 1992; Clark & Moss, 1996; Tobin, 1992). When the research involves children ethics are particularly important (Smith, 1995).

3.3.4 Ways of ensuring the trustworthiness of data generation and analysis

In interpretative research, it is the researcher who constructs a meaning for and representation of the events that have been observed (Erickson, 1986; Patton, 1990). The fact that “meaning is fundamentally indeterminate” (Scheurich, 1995, p. 249) raises questions about the trustworthiness of the data and its interpretation. Or as Salomon (1991, p. 10) asked, “How would one know how to distinguish a scholarly interpretation of a classroom event from that of a delirious observer?”.

Validity, reliability and generalisability, the traditional criteria for quality in research, have no functional value in interpretive research where the social context is central and the researcher, if he or she is visible, is part of the context (Guba & Lincoln, 1989). Guba and Lincoln (1989) propose that interpretive research needs to be trustworthy. It is generally agreed that the trustworthiness of the research ultimately resides with the reader: the extent to which he or she is willing to use the study in their own theorising or research (Maykut & Morehouse, 1994). Trustworthy research has credibility, transferability, confirmability and dependability (Guba & Lincoln, 1989). These criteria are increasingly being used (see for example Schaller & Tobin, 1998; Surry & Roth, 1999; Waldrip & Taylor, 1999) as the means of ensuring the data generation and analysis is reasonable and justified. Each is discussed in turn.

According to Guba and Lincoln (1989), credible data generation and interpretation requires prolonged engagement, persistent observation, peer

debriefing, negative case analysis, progressive subjectivity and member checking (Guba & Lincoln, 1989, pp. 236-241). Prolonged engagement ensures the researcher has substantial involvement in the setting in order to overcome the effects of misinformation, distortion or presented “fronts”, to build up trust and rapport and to develop sensitivity to the situation and people’s responses. Persistent observation allows the researcher to identify issues that have the most salience and to study them in depth (see also Delamont, 1992; Maykut & Morehouse, 1994; Walsh & Graue, 1995). Peer debriefing allows a researcher to describe what is happening and to discuss tentative hypotheses with a disinterested peer who can then pose questions and suggest alternatives. Negative case analysis is a process of thoroughly checking all discrepant data and making sure they can be explained. Progressive subjectivity involves a close analysis of the evolving constructions to ensure the researcher’s initial constructions are not privileged. Finally, and most crucially (Guba & Lincoln, 1989), member checking involves checking data and interpretations with participants as they must at least recognise the meanings attributed to them (see Bronfenbrenner, 1979; Erickson, 1986; Lather, 1992 for a similar criteria). Member checking allows the researcher to assess the intent of an action, gives the participants a chance to correct errors of fact or interpretation, to provide additional information and confirms the researcher has “got it right”.

Transferability, the second of Guba and Lincoln’s criteria for trustworthy research, relates to the use of thick descriptions so the reader may decide whether to use the study as a basis for their own theorising and empirical research (see also Mishler, 1986). It provides for ecological validity in the reporting of the data. Dependability and confirmability, Guba and Lincoln’s final criteria, relate to the need to ensure changes in research methods are documented and made available to others. These criteria are adopted in this study.

In review, it is the researcher who constructs a meaning for the data that is generated in interpretive research. Guba and Lincoln’s criteria provide a strategy for ensuring the trustworthiness of qualitative interpretive research; the viability of the assertions and the overall adequacy of the findings.

3.4 The research design for the study

In this section the research design for this study is set out. Details of who participated, how data were generated, the units of analysis and how the trustworthiness of the data and interpretation was ensured are outlined.

3.4.1 Summary of data collection and time line

Data for the study were generated as part of the Learning in Science Project (Assessment) (see Chapter 1, Section 1.6 for details) in two phases during 1995 and 1996. In the first phase of the study (February - June 1995), ten Year 7 -10 teachers of science and three students of each teacher were interviewed to ascertain their views of formative assessment. The interviews were supported by three to five classroom observations. In phase 2 (July 1995 - October 1996), the teaching, learning and assessment of a complete unit of science were observed for each teacher. The teacher and at least three students were interviewed about their classroom experiences after some lessons and at the end of the unit. Alongside this, the teachers participated in eleven teacher development days. Table 3.1 summarises the data collection methods and time line and then the teachers, students, interviews and participant observations are described in detail in the next sections.

Table 3.1: Data collection methods and time line

Phase	Interviews about formative assessment	Teacher Development days	Classroom observation	Interviews about classroom experiences	
Phase 1 Feb- June 1995	10 teacher semi-structured interviews 3x10 student interviews	2 days	3-5 lessons observed with each of the 10 teachers		
Phase 2 July 1995 – Oct 1996	End of year semi-structured teacher interviews	2 days	July – Dec 1995 A science unit observed for 4 intermediate and 1 secondary teacher	End of unit interview for 4 teachers End of lesson interviews for 1 teacher	End of unit interviews for 3 students of each teacher (the same students as phase 1)
	End of year semi-structured teacher interviews	7 days	Feb- Oct 1996 A science unit observed for 1 intermediate and 4 secondary teachers	End of lesson interviews for all teachers	End of lesson group interviews for students (new students)

3.4.2 Multiple Perspectives

Formative assessment is an activity that involves teachers and students and so three perspectives on formative assessment in the classroom were obtained: those of the teachers, the students and the researcher.

The teachers

In February 1995, all local urban schools with Year 7-10 classes were sent a letter inviting them to register interest in being involved in the Learning in Science Project (Assessment), along with information on the purpose of the project, the professional benefits, and their obligations if they joined the project. All schools responded positively as they had teachers who wished to be involved. The teachers were named by the school managers. From these names, ten teachers were selected so that two teachers came from each of five schools; there was a

mix of intermediate and secondary school teachers and there was a mix of teachers with and without experience of being involved in previous Learning in Science Projects. Table 3.2 sets out details of the teachers' background.

Table 3.2: Summary of participating teachers' background

Teacher Code (Case study number)	Qualifications of teacher	Years of Teacher Experience	Year Level of observed class
1 (1)	T.T.C.	20	7
2	Higher Teaching Certificate	8	7
3 (4)	M Sc., Dip Ed Dip T	25	10
4 (1)	B Ed	10	7 & 8
5 (2)	B Ed	17	8
6 (1)	Dip T	1.5	7 & 8
7 (6)	B Tech	15	9
8 (3)	B Sc Dip T	12	9
9 (5)	B Sc Dip T	14	10
10 (4)	B Sc Dip T	14	10

Note: Teacher 9 subsequently moved schools so that in 1996 there was one school with one participating teacher and another with three.

The students

The interviewed students were volunteers. During phase 1 (January - June 1995) all students in the class chosen by the teacher to work with them on the project were asked by the researcher or by their teacher if they would be prepared to be interviewed individually. Their response varied from most wishing to be involved in the Year 7 and 8 classes, to only three or four responses in the Year 10 classes. The teachers selected three students to be interviewed. The criteria for selection were that the students be thoughtful and able to communicate - a high level of performance in science was not a criteria. In one class, only four students wished to be interviewed and so all four were interviewed. In another class, four students

who worked together were interviewed rather than exclude one of them. Of the 32 students involved in phase 1, there were 13 boys and 19 girls; ten Year 7, five Year 8, seven Year 9 and ten Year 10 students. Only four of the students worked together as a group all the time, the others were involved in group work but not in the same group. In three classes, the groups were periodically changed by the teacher.

During phase 2, the students of Teachers 1, 4, 5, 6, 10 were interviewed again as part of the five case studies developed in 1995. In 1996, in a new school year, the teachers were working with different classes and the researcher recruited the interviewed students through her participant observations. During the first participant observation with a class, the researcher sat in a vacant seat and worked with the students around her. After three or four lessons, she asked the students if they would be prepared to talk with her about their experiences (All the students asked to participate agreed to do so). Hence, the students interviewed in phase 2 were selected at random on the basis of where there was a spare seat in the classroom - this varied from being near the front to at the back of a classroom. Additional students who requested interviews were interviewed and in the case of Teacher 8 all the class participated in at least one interview (see Bell & Cowie, 1997 for further details).

The researchers

Three researchers participated in the Learning in Science Project (Assessment) and hence were involved in aspects of the data generation and analysis reported here. The background of the writer, who conducted the classroom observations, was outlined in section 1.7.2. Beverley Bell, the Director of the Learning in Science Project (Assessment) was involved in teacher development days and the data analysis for the report to the Ministry of Education (Bell & Cowie, 1997) but was not involved in the more detailed analysis of the student views set out in this study. Carol Boulter, a visiting researcher, worked with the researcher at the end of 1995. She had undertaken classroom based research in England and was involved in the data generation and analysis with Teachers 1, 4 and 6. Her presence allowed for the triangulation of the participant observation data (see Cowie, Boulter & Bell, 1996 for further details).

3.4.3 Multiple data generation methods

Data were generated through participant-observation, audio-taped interviews, surveys and audio-taping teacher development day discussions. The data generation means are summarised in Table 3.3 and described in more detail below.

Table 3.3: An overview of the data generation methods

Teacher Code (Case study number)	Dates of classroom observations	Student interviews for the case study	Teacher interviews for case study
1 (1)	9 observations 26/7/95 to 18/8/95	3 student EOU interviews	1 EOU 95, 96 EOY
2 (5)	7 observations 16/8/96 to 10/10/96	7 groups = 17 students 9 EOL interviews	5 EOL 95, 96 EOY
3 (6)	17 observations 7/6/96 to 9/8/96	5 groups = 11 students 6 EOL and 2 EOU interviews	6 EOL 95, 96 EOY
4 (1)	14 observations 17/7/95 to 15/8/95	3 students EOU interviews	1 EOU with T6 95, 96 EOY
5 (2)	16 observations 12/10/95 to 24/11/95	7 students EOU interviews	6 EOL 95, 96 EOY
6 (1)	14 observations 17/7/95 to 15/8/95	3 students EOU interviews	1 EOU with T4 95, 96 EOY
7 (8)	14 observations 22/4/96 to 24/5/96	2 groups = 7 students 9 EOL interviews	8 EOL 95, 96 EOY
8 (3)	16 observations 4/6/96 to 30/7/96	9 groups = 23 students 17 EOL interviews	6 EOL 95, 96 EOY
9 (7)	11 observations 5/2/96 to 3/4/96	2 groups = 7 students 10 EOL interviews	10 EOL 95, 96 EOY
10 (4)	10 observations 8/9/95 to 20/10/95	4 students EOU interviews	1 EOU 95, 96 EOY

EOL = interviews at the end of the lesson

EOU = interviews at the end of the unit

EOY = interviews at the end of the year in 1995, 1996

The participant observation, interviews and documentary data generated in the study are discussed next.

Participant observation in this study

In the study, the researcher's role was negotiated with the teachers as that of a participant-observer. The researcher would become part of the classroom in the role of researcher in a manner that would minimally influence the learning and assessment, while keeping her integrity as a person deeply interested in what was happening (Ball, 1985).

The researcher's classroom actions were important for establishing her intentions and her credibility as a person who was interested in and respected student ideas (Delamont 1992; Fine & Sandstrom, 1988). The researcher did not act as a teacher. She waited with the students for the teacher to arrive for lessons. During whole class discussion, she observed the teacher and "the class" and did the work assigned to the students. During group work, she participated in a group with the group leader's permission and observed what was happening within the group or within the class from the perspective of the group. There was a delicate balance between appearing interested and influencing what was happening as a teacher might. Requests for help were usually responded to by referring to what was written on the board, referring back to what the teacher had said or by suggesting the students ask the teacher. The researcher considered she successfully established her role as a participant-observer interested in student views because after four or five lessons students saved a seat for her and did not ask her for help.

Field notes were used to record the participant observation data because of the aspects of flexibility, unobtrusiveness and immediate access (see Cowie, Boulter & Bell, 1996 for details). They enabled a wide range of data to be collected and recorded in a situation where the researcher was unsure where the important actions were going to take place and what they might be. The researcher was able to move with students when they were grouped and regrouped or when they went outside and to move and join a group when she was invited to. Field notes could be annotated with notes on links to previously seen events and to highlight aspects which are considered important such as who initiated questions, the pattern of interaction between individual students, the teacher and the class, and the movements of the teacher and students. For example, during one lesson, while the students were doing a cloze test, the researcher had the opportunity to study, in detail, what was displayed on the classroom walls and came to appreciate the

importance of this documentary material as evidence of assessment within the classroom. Moreover, writing was an activity which the students were doing much of the time in the classroom. The students accepted that the researcher was taking notes to help her remember what was said and done (Maykut & Morehouse, 1994). Furthermore, the researcher's field notes did not have to be hidden. During the observations, the researcher allowed students to look over her books if they wished. In one class, the students commented to the researcher on her poor presentation skills, and clearly found the writing of field notes a very normal activity. When students asked if anything had been written about them, they were shown the notes at an appropriate point. The immediate access to field notes as a record facilitated peer debriefing.

Field notes were complemented by the researcher's "head notes". Head notes are the record of the observation that a researcher retains in her head (Sanjek, 1990). They are subject to change as events are reflected on, interpreted and re-interpreted. They were called up to add to the field notes and their interpretation. For example, it was not until near the end of the unit of work of Teachers 4 and 6 (see Case study 1) that the researcher appreciated the importance of what was displayed on the walls. When and what items were displayed should have been systematically monitored and recorded in her field notes. However, she was able to review her field notes in conjunction with her head notes to recollect when material had appeared on the walls. Later, she was able to record when additional information was displayed.

Interviews in this study

Interviews in the study were conducted as a conversation with a purpose (Maykut & Morehouse, 1994; see also Cohen & Manion, 1994; Lincoln & Guba, 1985; Miles & Huberman, 1994; Mishler, 1986; Patton, 1990; Powney & Watts, 1987; Scheurich, 1995; Smagorinsky, 1995; Tobin & Tippins 1993). The ten teachers and some of their students were interviewed during the study.

Teacher interviews

There were three sets of interviews with the teachers (see Table 3.3). In the first set of interviews (Phase 1, January - June 1995), the teachers were interviewed about aspects of assessment. The interview started with the teachers being asked

to describe a successful lesson or activity and then moved into a discussion on the teachers' view of assessment, its link with teaching and learning, assessment activities used, influences on assessment and reporting (see Cowie & Bell, 1995 for further details). All the interviews were audio taped and transcribed verbatim by a transcriber. Each teacher read and approved his or her own transcript for use as data.

The second set of interviews was conducted after a unit and/or lesson following the 1995 and 1996 classroom observations. These focused on the teachers' impressions and interpretations of the learning, teaching and assessment which had taken place during the unit or lesson which preceded the interviews. They began with the researcher asking the teacher if he or she considered they had engaged in any formative assessment during the lesson and if anything had surprised them. Sometimes she asked for the teacher's interpretation of episodes which she had identified as significant. This process of reflecting on a lesson was described cogently by Jarworski as:

The teacher talks aloud for the benefit of the researcher from *within* her perceptions of the lesson. The researcher tries to engage in conversation from *outside* her perceptions of the lesson, trying to operate simultaneously at two levels - engaging with the teacher about the lesson, and keeping an overview of the conversation with the teacher and what, as researcher, she is learning from it. (Jarworski, 1994, p. 190)

The nature and duration of the discussions depended on the teachers' work commitments immediately following the lesson. They ranged from hour long audio-taped analyses of the lesson, to quick discussions while the teacher and the researcher walked around doing duty during interval and lunch time to telephone conversations in the evenings.

The third set of teacher interviews was conducted at the end of 1995 and 1996. Each teacher was interviewed to monitor their views of assessment and to ask them to reflect on the emerging model of formative assessment. The semi-structured interviews contained the questions along the lines of those in Table 3.4:

Table 3.4: Teacher interview questions

Interview questions for end of 1995	Interview questions for end of 1996
Do you feel your thinking has changed about assessment?	What assessment have you been doing lately?
Do you have any thoughts on: the purposes of assessment? planning for assessment?, how to collect assessment information? what assessment information you collect? how you use the assessment information?	How do you decide if the students have learnt or understood ideas? Have your ideas on formative assessment changed during the year?
What sort of things tell or show you that student doesn't understand or can not do something?	Do you have any comments on the model for formative assessment? What role do you consider you have in the process of formative assessment? / What metaphor do you use for the process of formative assessment?
What sort of things do you do when you find out a student cannot understand or do something?	How do you report on the information you gather through your formative assessment?
What issues do you see for assessment within the school?	How would you define formative assessment?

In review, the teachers were interviewed to obtain their thoughts on formative assessment and their perceptions of the formative assessment they had undertaken during a lesson or the observed unit.

Student interviews

There were two sets of student interviews (see Table 3.3). The first set of student interviews occurred during phase 1. At this time, the purpose of the research was explained as “to find ways to help students learn more effectively” and the purpose of the interview as “to find out their ideas”. The interviews began with the researcher asking students to describe what they had done or learnt in the lessons preceding the interview. They proceeded with a semi-structured discussion around the following themes:

How do you think the teacher finds out what you know and understand?

Given that you have spent x years in school as a learner, what suggestions do you have for teachers about how they could find out what you know and understand?

What difference does it make to your learning that the teacher knows what you understand?

How do you decide that you have learnt something?

How does the teacher let you know what they think you understand?

How do you use this information?

The students received a copy of the transcript of their interview to add, delete and approve the use of the data. No changes were requested.

The second set of interviews took place during phase 2. The format of the interviews evolved from interviews with individuals at the end of a unit to individual and/or group interviews at the end of lessons (See Table 4.3). During these interviews the students were asked to describe what they had learned or clarified during the unit /lesson and if they thought the teacher had assessed (found out anything about their thinking) or helped them during the lesson. The researcher pursued ideas introduced by one student in later interviews and so not every student or group discussed the same issues. The issues raised included the significance of the language and taken for granted teacher actions such as their looking at student books and the importance of peers.

The issues associated with interviewing adolescents were manifest in the study in a number of ways. Firstly, it was not possible to ask the students about “assessment” or “formative assessment” because they were not familiar with the terms (Cowie & Bell, 1995). Assessment was referred to as a process whereby students and teachers “find out” about student thinking and / or learning.

Moreover, as was pointed out by Scheurich (1995) the “language out of which the questions are constructed is not bounded or stable; it is persistently slippery, unstable, and ambiguous from person to person, from situation to situation, from time to time”. An instance of this confusion occurred when the researcher asked three students if they had ‘learnt’ anything during a lesson. On three occasions they stated they had not (SG91/L1,2, 3/96). The researcher was surprised by this because their discussions had suggested they were exploring and making sense of

the idea of a scientific “control”. She realised, and the students confirmed, they were interpreting this question as “Did you learn anything new?” and because they considered their previous ideas had been confirmed and clarified they stated they had not learned anything new.

There was evidence that participating in a series of interviews raised students’ awareness of teacher assessment. Ten students indicated that being interviewed about their own and their teacher’s actions resulted in their thinking about and paying more attention to their teacher’s actions. In one group of three, only one student commented on the teacher’s assessment actions when asked during the first interview. Two interviews later the other two students said they were noticing with whom and how the teacher was interacting. They attributed this change to being involved in the interviews. In contrast, one group of three boys remarked to the researcher that she had asked them about the teacher’s learning goals and assessment for the lesson preceding the interview four times. Their comments indicated they had not considered this during any of the lessons.

Interviewing the students a number of times had advantages. As trust developed the students raised a number of issues. These included the importance of their books and teacher language, their dislike of teachers standing behind them and disclosing their ideas to others. Once pointed out, the researcher was able to note when these incidents occurred and was more sensitive to opportunities to discuss these issues during interviews with other students. Observation and interviewing of students over the course of a unit enabled the researcher to develop sensitivity to student responses. For example, over the sequence of interviews one student revealed she was particularly concerned about receiving positive public feedback, another that she was concerned about whether the teacher liked her, a third that peers were an important source of feedback, information and support (SG71/L5/96 - see page 82 for an explanation of the codes). Two other students repeated their dislike of teachers discussing their individual concerns with the class (SG91/L5/96, SG74/L7/96). Some students also appeared to be sensitive to how the researcher might perceive their teacher as a consequence of their comments. On three occasions groups of students stated explicitly that the comments they were making were generalisations rather than statements about their teacher (the teacher involved in the research).

The group interviews in 1996 appeared to provide the students with opportunities to set the level and context of an interview. For example, a student introduced the notion that she had assessed the teacher and the other group members discussed why and how they assessed teachers. However, in one group (three boys) a student always distracted his peers when they started analysing what had happened in class. It appeared that the researcher and the student did not share the same purpose and this student resisted the joint construction of meaning (Scheurich, 1996).

Documentary data

Documentary data on the formative assessment occurring in the classrooms were also collected. Student and teacher interactions were often mediated by the use or production of documentary data in the form of text or pictures. Student books, the board, and the walls were used to record tasks and understandings and as places for the negotiation of meaning. This documentary data was recorded as field notes (see Cowie, Boulter & Bell, 1996). The teachers' plans for the units and their record books were also photocopied as sources of data.

3.4.4 Management and coding of the interview and participant observation data

The interviews were transcribed verbatim by a transcriber employed for the Learning in Science Project (Assessment). The transcripts were checked by the researcher through a comparison with the audio taped and notes from the interview session. Field notes were stored as written.

All data collected and reported was coded to provide a reference to the data and to protect the anonymity of the data sources. In this report, the teacher end-of-lesson interviews are coded, for example (T2/D8/96) where T2 represents teacher 2, D 8 the discussion after lesson 8 with this teacher, in 1996. The teacher end-of-unit interviews are coded, for example (T2/I/96) where T2 is teacher 2, I an end-of-unit interview, in 1996. The teacher end-of-year interviews are coded, for example, T2/EOY/96, indicating the 1996 end-of-year interview with teacher 2.

The student individual interviews are coded, for example, (S24/I/95a) which is the code for an interview with student 4 of Teacher 2 in phase 1 in 1995.

Individual student end-of-unit and end of lesson discussions in phase 2 in 1995 and 1996 are coded (Sxx/I/95b) and (Sxx/I/96). Student end-of-lesson group discussions are coded, for example, (SG75/L3/96) which is the code for a discussion with group 5 of Teacher 7 after lesson 3 (L3) in 1996. The student member checks are coded for example (Sxx/MC/96).

The field notes are coded, for example (T2/FN4/96) which indicates the item is a field note (FN), taken during lesson four of teacher 1, in 1996. The head notes and documentary data were recorded in the field notes and had no separate code.

The analysis of the audio taped transcripts of the teacher development days was done by coding each distinct segment of discussion. Hence, the quotations documented may represent the speech of more than one person as it is of a segment of talking, rather than the contribution of a single person. A segment might be the ideas of one or several teachers. The code used to identify the quotations is, for example, TD10/96/28.2, referring to the second data segment, on tape 28, recorded on the tenth teacher development day which was held in the second year of the project, 1996.

Field notes were also taken at these days and used to inform the data analysis. No coded data from these field notes are recorded in this study.

3.4.5 Ethics

The ethical issues of informed consent, confidentiality and potential harm were addressed in the study in an ongoing manner. The procedures the researcher would follow in obtaining informed consent, in maintaining the confidentiality and accuracy of transcripts, in monitoring for potential harm during the data generation and from the proposed use of the data were explained to the teachers at the beginning of the study. The teachers' written informed consent for the procedures was obtained. Information on these procedures was supplied to students and their caregivers and their informed consent was obtained at the beginning of the study. Informed consent for the involvement of the teachers and

students was also obtained from school principals and through them, Boards of Trustees.

Confidentiality was of particular concern as the research was conducted in a relatively small city, where most of the people in education know each other. The researcher knew many of the participants. The classes and teachers knew the researcher was interviewing students and teachers after the lessons.

Because the researcher was interviewing students and the teacher after the lessons and working with the teachers on teacher development days, she needed to be constantly aware of where and from whom she had gained different information. Demonstrated confidentiality was important for the development of the trust needed to support open discussion with the students. Some students tested the meaning of confidentiality by asking the researcher what other students had discussed with her and what their teacher had said.

The students were concerned not to cause harm to their teachers. They made sure that the researcher was aware when a negative comment or criticism did not apply to their teacher.

Confidentiality was maintained in the publication of data through the use of coding. The teachers and students were identified through a number. Attention was paid to whether the inclusion of specific details might serve to identify students to their teacher and teachers and students to the wider community.

3.4.6 Strategies to ensure trustworthy data generation and credible data interpretation

The research processes met the criteria for trustworthiness as proposed by (Lincoln & Guba, 1985) in the following ways. Prolonged engagement and persistent observation were achieved as the researcher studied the same classrooms on two occasions; the second time for a minimum of three weeks. This meant the researcher, teacher and students built up a body of shared experiences both inside and outside the classroom. The researcher was able to learn more about the students and to find threads within the comments they made.

Prolonged engagement permitted the researcher to explore the same issues over a number of interviews, to reflect on whether she and the students and teacher had been talking about the same things, to ask about events or statements she only appreciated as relevant after an interview and to compare and contrast different lessons with those interviewed.

Peer checking was achieved by the presence of two observers at during the data generation in phase 2 with teachers 1, 4 and 6. Both researchers were present in the classroom taking field notes thus increasing the depth of the observations by providing two perspectives. The field notes were compared as a check on their comprehensiveness (see Cowie, Boulter & Bell, 1996). In addition, the ongoing analysis for the Learning in Science Project (Assessment) (Cowie & Bell, 1995; Cowie & Bell, 1996a) was peer checked during two advisory research meeting days organised as part of the research contract, by the funding agency.

The analysis was member checked by the teachers and students. After the classroom observations in 1995, the researcher sometimes asked the teacher about events noticed, what had surprised her or him and whether she or he considered they had formatively assessed students. These comments were field noted as data but were compared with and used to inform the researcher's interpretation of the assessment events in the lesson. During 1996, the teachers and the researcher planned to discuss the observed lessons after the lesson. In addition, each of the teachers read their case study. The ten teachers as a group checked and contributed to the model for the process of teacher formative assessment which evolved during the research through discussions on ten of the eleven teacher development days held over the two years, 1995-96 (Bell & Cowie, 1997, pp. 259-276). The teachers also commented on the model during their final interview for the project at the end of 1996.

Some of the students were also involved in member checks. Discussions with students during some lessons generated additional data and served to monitor the researcher's ongoing interpretation of formative assessment in a particular classroom. In addition, three groups of students formally member-checked the researcher's analysis of their perceptions and experiences of formative assessment.

The first formal student member check took place as the researcher was seeking to clarify what the teachers assessed. Students of teachers 4 and 6 checked the researcher's interpretation of what their teachers were assessing as important against what they considered important. To do this, they sorted twelve statements into two piles (important and not important) and then ranked with explanations the pile they had identified as important. The statements were about whether learning science involved co-operating with others, thinking for one self, making links with everyday events, performing experiments or developing concepts.

The second member check involved two groups of students of Teacher 9. The students had been interviewed in their groups at the end of most observed lessons. The researcher reported her analysis as the 'story' she had constructed to make sense of what they had told her using a hand written diagram as a prompt. The story focused on the types of interactions (student - student, student - teacher, class - teacher) involved in formative assessment and the nature and impact of feedback. The students indicated they agreed with the analysis although they suggested more attention needed to be paid to the use of language in the classroom.

The third instance of member checking involved students of Teacher 7. The researcher worked with Teacher 7 immediately after Teacher 9. Once again, two groups of students had been interviewed after many of the observed lessons. In this case, the researcher reported her analysis through the use of selected student interview quotes. The quotes were presented one per page. Of their own volition the students identified who had said what and then one of them selected a quote for group discussion. This process continued until all the quotes had been discussed. The students indicated they considered the selected quotes represented the main issues that had emerged from their discussions with the researcher.

Transferability, the second of Guba and Lincoln's criteria for trustworthy research, was provided through the compilation of case studies. These provided detailed descriptions of the formative assessment that was observed in particular classrooms (Chapter 4).

Finally, dependability and confirmability are provided for through the detailing of the changes in the methods used to generate the data (Table 4.1 page ?). Two significant changes were made. Firstly, the interviews and brief observations in phase 1 indicated that formative assessment was a strongly contextualised process (Cowie & Bell, 1995) and it was decided that to understand formative assessment in a classroom it was necessary to observe the teaching, learning and formative assessment over a whole unit. Secondly, in 1996, the decision was made to interview, where possible, the teacher and students after each lesson in order to more fully explore their perceptions of the formative assessment they had participated in.

3.4.7 The analysis and units of analysis

The final consideration in planning and conducting the research was the unit of analysis. The ideal unit of analysis for interpretive research is “the ecosystem of the classroom teacher, school and community” (Shulman, 1986, p. 21). The unit of analysis determines, “What is it you want to be able to say something about.” (Patton, 1990; Wertsch, 1991).

The units of analysis that emerged in this study are a result of attempts to describe how teachers and students separately and together viewed and experienced formative assessment and to theorise on the process as it occurred in the classrooms during science lessons. The identified units were: case studies with nested episodes or cameos of formative assessment (Chapter 4); a framework that portrays the scope of how students viewed and experienced formative assessment but does not illustrate student responses at an individual level (Chapter 5); a cross case analysis that describes the ways in which formative assessment was situated and realised in classrooms (Chapter 7). Each unit is discussed in turn.

Case studies as a unit of analysis: Chapter 4

Guba and Lincoln (1989, p. 223) suggest that the case study is a useful format for presenting interpretive research as it allows readers to “see how the constructors make sense of it (formative assessment in this case), and why”. In this study, the case study allowed for the study of the ways in which classroom interactions are shaped and transformed by formative assessment and formative assessment was

contextualised by the classroom (Moss, 1996; Perrenoud, 1998). It allowed clusters of assessment interactions to be examined, in context, to determine the conceptual basis that tied them to a particular model of instruction and subsequently to a theoretical perspective on learning (Rogoff, Matusove & White, 1996). Moreover, as a unit of analysis is consonant with a sociocultural view of learning with its emphasis on interacting individuals, situations, (learning) activities, goals and meanings (Newman, Griffin & Cole, 1989; Salomon & Perkins, 1998; Wertsch, 1991).

Assessment in the case studies is described at three grains of focus similar to those described by Rogoff (1995): the community, interpersonal and personal planes. This framework was useful to describe and discuss formative assessment because a focus on a particular plane foregrounded it while holding the other planes in the background. In this way it is possible to study the parts without losing the essence of the whole.

At the classroom grain of focus, the school, the class, classroom and science unit which framed teacher and student assessment opportunities and activity is set out. A typical lesson is described, where appropriate, to illustrate how patterns of action and interaction in a classroom shaped assessment. The second grain of focus was on the interpersonal which was represented by episodes or selected cameos of teachers and student formative assessment. These focus on the intricate detail of formative interactions and are used to typify or highlight the nature of formative assessment as it occurred in a particular classroom. The third grain is the personal and is represented by student and teacher perceptions of experiences and beliefs about formative assessment.

Student views as a unit of analysis: Chapter 5

The second unit of analysis is student views. In this chapter, the scope of the students' "local meanings" for what served as formative assessment and the effects of it are presented. Their views are presented separately as they not only commented on observed episodes of formative assessment they described and discussed past experiences and the experiences of peers and parents.

A collection of cases as a unit of analysis: Chapter 6

The third unit of analysis was a cross case analysis. Cross case analysis may be used to answer the question “do these findings make sense beyond a specific case?” (Miles & Huberman, 1994, p. 173). It allows for the development of more sophisticated explanations by viewing processes and effects across cases in order to understand how they are qualified by a particular setting. In this study, this approach emphasised similarities and differences in formative assessment across the different sociocultural contexts provided by the classrooms (Greeno, 1997; Rogoff, 1995).

3.5 Summary

An interpretative research methodology, congruent with the research questions and the epistemological underpinnings of the study was adopted. Data were generated through participant observation and interviews. The trustworthiness of the data generation and analysis was assured through the use of the criteria proposed by Guba and Lincoln (1989). The units of analysis that emerged from the study provide the framework for the following three data chapters. These are case studies of the formative assessment in each classroom (Chapter 4); the scope of student views (Chapter 5) and a cross case analysis that illustrates the general and particular aspects of formative assessment in each classroom (Chapter 6).

4. The Case Studies

4.1 Introduction to the case studies

This chapter sets out case studies of the formative assessment in seven classrooms to illustrate teacher and student experiences and perceptions of assessment.

The case studies document the data collected from the classrooms on assessment, not teaching. Assessment and teaching are obviously linked, but the distinction being made is that these case studies give accounts of the assessment, not teaching, activities in the classrooms. Hence, the case studies should not be regarded as a full account of the professional activities of any of the ten teachers.

The layout for the data in each case study is as follows:

- the setting
- reported teacher views of teaching, learning and assessment
- classroom formative assessment practices as identified by researcher
- summary and discussion of the nature, influences on and influence of formative assessment in the classroom

The setting is described in terms of the institutional setting (defined as school policy, class and lesson organisation); the physical context (the nature of the room, its layout and the resources that are readily available); the curriculum setting (the topic and assessment of the unit and autonomy of the case study teacher in deciding this) and the temporal setting (time in the school year as related to teacher and student knowledge of each other and the social norms that had been negotiated between them). A typical lesson is described, where possible, to illustrate the patterns of action and interaction in the classrooms.

Teacher views of teaching, learning and assessment are drawn primarily from the interviews at the beginning of the study and complemented by data from the interviews at the end of 1995 and 1996. These served as a framework for understanding teacher goals and actions.

Assessment as identified in the classroom reports on teacher and student assessment practices as seen by the researcher. In this section cameos, or specific episodes, of formative assessment in the case study classroom are presented. Where possible data on the teacher's and students' perceptions of what happened is included. The cameos highlight the main characteristics of formative assessment in the classroom with a focus on purpose and meaning. Sometimes additional data from other episodes of formative assessment is included in the analysis. However this section does not present all aspects of the formative assessment that was observed by the researcher in the classrooms.

The summary and discussion highlights the main points illustrated by each case study. The characteristics and influences on and influences of the formative assessment that was observed are set out.

The case studies are presented in the following order:

Section 4.2	case study 1	Teachers 4, 6
Section 4.3	case study 2	Teacher 5
Section 4.4	case study 3	Teacher 8
Section 4.5	case study 4	Teacher 3
Section 4.6	case study 5	Teacher 9
Section 4.7	case study 6	Teacher 7

The order of the case studies is not chronological but was determined for ease of the reader coming to know about a complex classroom activity. Each case study, while investigating formative assessment, focused on different aspects of the process. Formative assessment is strongly contextualised and many factors, such as the topic being taught, the teaching activities, the learning activities, the teacher's professional knowledge and the students, determined what aspects of the formative assessment process were available for investigation by the researcher.

4.2 Case study 1: Teachers 4 and 6

In this case study the views and classroom experiences of Teachers 4 and 6 and their classes are analysed. The emphasis of this case study is the breadth of what was assessed by the teachers as school science.

The case studies from the two classrooms are presented together because the two teachers worked as a team. They each had their own students but their classrooms were "linked" by another classroom. They often taught their two classes as a group and divided the students into two new classes. The teachers planned and prepared the observed unit together but the lessons were not taught in exactly the same sequence because of other commitments. The teachers visited each other's classroom during lessons. They discussed what was happening then and when they reflected on the lessons. The researcher moved freely between the two rooms during the period of the observation and often during a lesson.

4.2.1 The setting

As is usual in a Year 7 and 8 school, the teachers each taught their own class for all subjects (except technology) in their own classroom. The integration of curriculum areas this permitted was reinforced by a school policy that stipulated units should be integrated. The learning outcomes for the observed unit included the development of student question posing, research, co-operative and communication skills in addition to a focus on the development of the students' appreciation of the science involved in chemical cleaners. These additional aspects were summatively assessed through student self-assessment. The teacher's use of self assessment to assess the "main themes" of the unit was consistent school practice and the value placed on this skill (T4&6/I/95b). (See pp. 82 to 83 for a full account of the coding system.)

The teachers' decision to teach the observed lessons in their usual classrooms (not the school's sole science room) influenced their formative assessment. Equipment for practical work was put out at the beginning of the day to encourage students to "anticipate" what they would be doing (T4&6/I/95b; T4&6/FN3,4,5,8/95b; T4/EOY/96). Student questions and practical reports were put up on the walls throughout the unit and provided an accumulating record of the important ideas of

the unit. The teachers considered the display of student work allowed them to "model", rather than tell students what they desired in terms of content and presentation (T4&6/I/95b). Student books were also displayed for this reason (T4/FN4,6/95b; T6/FN4,5,6,7/95b). Student actions indicated they viewed the displayed work as an accessible source of information about what was valued by the teachers. They looked at the displayed books and practical results when they arrived in the morning. They commented if new work or their own work was on display (T4,6/FN5,6,8/95a). They consulted displayed reference material while designing a fair test of a household chemical (T4/FN4,5/95b).

The use of a non-specialist room had the disadvantage that it restricted the teacher's spontaneous use of empirical evidence to persuade students to reconsider their ideas (Cameo 1). Teacher 4 did not have immediate access to additional emulsions when her students were unable to identify the emulsifying agent in a mixture of oil, water and detergent. She prepared these overnight and showed them to the students the next day (T4/FN3,4/95b).

Practical activities, such as experimenting with lemon juice as a bleach and making and testing a red cabbage acid-base indicator, made the unit unique for the teachers and students - all looked forward to them with anticipation. The teachers considered practical work helped the students explain events (T4,6/I/95b), as Teacher 6 explained:

I find for my class that when they do practical activity they seem to take it in more and they can then use a stronger argument as to why things have happened. Because they've seen it happen. If you just tell them there's no reasoning behind it. (T6/I/95a)

The six interviewed students also considered practical work helped them to understand ideas because, as one student explained, "when you guess what happens or some of the things and they turn out different, you learn from that and you find out what it really is" (S44/I/95b).

However, doing practical work in a non-specialist room meant safety was an ongoing management concern for the teachers. Their assessment for management

purposes overlapped their assessment for the development of students' practice skills. The students self-assessed these skills as an aspect of their science learning (T4&6/FN6/95b).

In summary, the institutional setting supported the integration of science with other subjects and a focus on self-assessment. The teachers' decision to use their normal classroom for science lessons reinforced the integration of science and both restricted and enhanced the feedback actions available to them.

4.2.2 The teachers' views of teaching, learning and assessment

The teachers' description of learning construed it as a process of "movement", "change" and "progress" along a "track" and "up" a sequence of "levels". This process was seen as being facilitated by the sharing of ideas with the teacher's role being that of helping students "develop new skills" (T4/I/95a).

Assessment was described as "interlinked" (T6/I/95a) and "interwoven and moving through" (T4/I/95a) teaching and learning because students learn more when they "work at the level that they're suited to" (T4/EOY/96). The teachers assessed the students at the beginning, during and at the end of a unit to "make sure that progress is being done" (T4/I/95a). Assessment was described as feeding forward into teaching through a process of "finding out exactly where they are and thinking 'OK, this is there starting point. Where do I want them to go from here?'" (T6/I/95a).

Assessment was also described as a joint teacher-student responsibility because teachers could not assess every student every lesson (T6/I/95a). The teachers emphasised that assessment needed to encourage student independence and self assessment (T6/I/95a).

The importance of student books in the assessment process was emphasised by both teachers. They considered students' books served as a "record" of what the students had "learnt [and] what they know" (T6/I/95b), and hence as evidence of student "progress" (T4/I/95b). Student books were displayed to provide ongoing "feedback" to student (T4/I/95a) and to "share lots of logical answers" without

"telling them [the students] what is the right answer" (T4/I/95a). Student books also served an important role in communicating with parents. Parents were asked to comment on and sign student books at the end of a unit (T4&6/I/95b).

In summary, the teachers viewed assessment as integral to teaching and learning as a means of ensuring the students made the progress they intended. They considered student self-assessment played an important role in this process.

4.2.3 Formative assessment as identified in the classroom

The teachers' formative assessment practices were characterised by a focus on the whole student. They assessed their students' personal, social and science development as integral to their learning of science. Their assessment was focused by an explicit link to the learning purposes for the activities they used. Within this framework the teachers emphasised student self assessment, the ability to use the language of science and the development of personally meaningful explanations.

The teachers' assessed their students' social, personal and science development both formally and informally, formatively and summatively. The students' social development was an important long term goal for the teachers. A poster stating co-operation, communication and consideration for others were classroom goals was permanently displayed on one wall. The teachers assessed the students' social development as a part of assessing their science learning as the students' inability to co-operate and listen to each other had restricted the activities they had been able to use during a previous science unit (T4&6/I/95b). They were concerned to overcome this as the focus was on learning as a social activity (T4/I/95a). The teachers provided students with feedback on how they were working together (T4/FN6/95b; T6/FN5/95b) and required them to self-assess their group work skills at the end of the unit. Teacher 4 described these skills to her students thus:

Moving to group co-operation. [pause] You selected groups to work with. You ... [used] lots of equipment. People cleaned it. Decided where to place it. Discussed about predictions and conclusions. We're not talking about your group but your individual performance. Listening to others' ideas.

Sharing jobs and not dominating. So how did you co-operate? You don't think you co-operated and you need to improve down this end. You co-operated, here. (T4/FN6/95b)

The students appeared to value group work and co-operation. They monitored individual involvement in group activities without specific teacher direction. For instance, groups rotated the practical tasks involved in using indicator paper to test a range of substances and sought consensus before recording their predictions and conclusions (T4/FN4,5,6/95b). The six interviewed students stated working with others was important. One student asserted co-operation was necessary before any learning could occur (S64/I/95b). Another explained that when she was a group leader it was her responsibility to ensure that all group members had the chance to be involved (in practical work) and to express their opinion (S62/I/95b).

The teachers assessed students' personal development in relation to their attitude, motivation, time management skills, ability to make decisions and think ideas through for themselves, their ability to be responsible for their own decisions, to self-assess, to follow instructions, to pose questions, their presentation and their learning-to-learn skills. Aspects of personal and social development were interlinked as much of the development and display of the personal skills necessarily took place in a social context. Within this analysis, a student's personal development is considered to have an emphasis on the learner. An example of this focus occurred when Teacher 4 asked the students to compare three samples of indicator paper and deduce if there had been a change (T4/FN5/95b). The students were then asked to vote for the same or different using a show of hands. The teacher noticed that initially only a few hands went up and said "I watched how you looked around the room, saw others and then made your decision from what you saw I hoped you wouldn't need to do that in this room ... " (T4/FN5/95b).

The teachers' and students' typical formative assessment practices and experiences are illustrated by the following cameo.

Cameo 1: An investigation of emulsifying

This cameo illustrates the role of an explicit lesson purpose and the importance the teachers placed on the use of scientific vocabulary and personal meaning making. It was selected because both teachers were observed (they used the activity on different days) and it was embedded (by chance) in a summative assessment activity (drawing a flow diagram of the process) and so the teachers discussed it with the researcher on two occasions.

The teachers' stated purpose for the emulsifier activity was: "To see if an emulsifying agent will mix water and oil" (T4/FN3/95b). Both teachers handed out a flask and then measured amounts of water and oil to each group. They discussed how to draw a "scientific diagram" of the flask and its contents with the students and then the students recorded what they saw. Next, the teachers handed out bungs, and ensured the students knew how to put them in. The students shook the flask. They rested the flask and waited to see what happened - it was agreed the oil and water separated given time. The teachers added detergent to each flask and the shaking was repeated. The teachers asked the students to describe what they observed. This included a change in colour, bubbles at the top and a layer between the oil and water. After this, the two lessons proceeded differently.

Teacher 4 questioned her class about what had happened and which of the liquids was the emulsifying agent (T4/FN3/95b). The students were unable to identify this and appeared confused. She focused them on the lesson purpose, reading and re-reading it and asked again which was the emulsifying agent. The students suggested the detergent and oil and the detergent and water were being mixed.

Teacher 4 summed up the lesson saying:

I don't think we have achieved today's purpose we need to look at mixing more liquids tomorrow and adding an emulsifying agent hopefully this will help you work out which is the emulsifying agent. (T4/FN3/95b)

The lesson concluded with her talking about mayonnaise and asking the students if they could bring some vinegar to make mayonnaise the next day.

In this instance, Teacher 4 articulated to the class her assessment that they had not achieved the purpose for the lesson. She indicated she perceived the area of misunderstanding involved which of the liquids was the emulsifying agent and drew the students' attention to the lesson purpose. This action was typical of the importance and use the teachers made of lesson purposes. The teachers stated they "gauge[d] back to the purpose" of an activity to assess student understanding (T4/EOY/96) thereby suggesting they served as assessment criteria. Lesson purposes were considered to provide students with a "point" for doing an activity beyond that of being busy. They were seen as providing criteria for students to use in their self-assessment (T4&6/I/95b), as Teacher 4 explained:

They [the students] know what they're supposed to be gaining from the activity that we're doing" (T4/EOY/96).

All six interviewed students referred to recorded lesson purposes when asked by the researcher to describe what they had learned. It appeared their recording of a purpose for each activity and the explicit teacher assessment of whether they had met the lesson purpose communicated to the students it was this that the teachers intended them to learn.

The teacher's action in making her assessment explicit and appealing to empirical evidence, albeit delayed and recalled, discussion and involving the students' everyday experiences (of mayonnaise) to help them make sense of ideas was representative of those taken by both teachers. It served to construe the students as thoughtful. It was also typical in that her feedback and the lesson purpose construed school science as a description of what happened rather than how or why. The need to prepare further emulsions overnight was a consequence of the lesson taking place in a non-specialist room.

Teacher 6 concluded the activity differently. The students described what they could see, identified the emulsifying agent and then she asked them to write a conclusion for the activity to explain "why the bubbles, why the colour change" (T6/FN4/95b). On this occasion and again the next day the students focused on what they could see. The teacher accepted their observations as satisfactory evidence of understanding.

At the end-of-unit interview, the teachers discussed the students' summative assessment flow diagrams of the emulsifier activity. Their analysis of student responses indicated they made norm and science-criterion referenced interpretations. For example, Teacher 4 commented:

The soap keeps the bubbles of oil apart so they are floating in the water...that's OK. (T4&6/I/95b)

They indicated this was an appropriate "level" of explanation for their students.

The teachers' analysis of the emulsifier activity indicated they valued answers in which the students "justified" their ideas, Teacher 4 explained:

We didn't really achieve the purpose of the actual lesson. ... it was good in that you had students justifying why they thought something and they were very strong in what they thought. It was not quite the right answer that one would have expected, but they were, I mean to me that was a learning curve in that they could justify using their own words, why they thought something happened. (T4&6/I/95b).

The teachers' valuing of personal meaning making was congruent with their emphasis on student thinking on other occasions. For example, Teacher 6 reinforced the importance of students thinking ideas through when they tested which substances were acids and which were bases (T6/FN5/95b).

Student actions suggested they assessed their ideas. An example occurred when a student negotiated with the teacher about the acceptability of his prediction of "What will happen to the water when the crystals (potassium permanganate) are added?" (T6/FN4/95b). There was discussion in the group of which the researcher was part: (T6/FN4/95b):

- S1 What happens to the water?
- S2 I don't know.
- S3 It will go all blurry.

S1 It will go all blurry, it will go foggy.

and later:

S1 What is your prediction?

S4 The water will be all dark.

and later still when the potassium permanganate had been added:

S1 Wow

S2 It's light at the top and dark at the bottom

When Teacher 6 had given all the groups potassium permanganate, she stopped the class:

T Look at the colour. Check if your prediction was right and wrong.

S1 What about sort of ? (And the students read out their prediction)

S2 What about if I said it would go all blurry and mixed in.

T (inaudible)

S1 It didn't go blurry but it did mix in.

T A good question if you are half right and half wrong then write down what actually happened. Which half is right and which is wrong?

(T6/FN4/95b)

Another aspect of the teachers' analysis of the emulsifier flow diagram was their commenting on the students' vocabulary. They had included the task to show students' ability to "use some science vocabulary in explaining the steps (of using an emulsifier)" (T4,6/I/95b). Of a student who had used the term "molecules", Teacher 4 said:

I hadn't expected them to talk about molecules. I think it's because of the molecules it will work that one says to me doubts, she doesn't really understand but she's picked up some key words. (T4/I/95b).

The teachers viewed the learning of scientific vocabulary, including how to draw scientific diagrams, as important (T4/I/95a; T6/I/95a). It seemed they perceived learning school science involved learning scientific vocabulary. They used a summative cloze task to assess "whether they had knowledge right throughout the unit" (T4,6/I/95b). The emphasis was on the appropriate use of terms, not on recall, as the teachers encouraged the students to refer to their notes and reference material during the task (T4/FN6/95b; T6/FN7/95b).

The six interviewed students told the researcher that it was important to form their own opinion and it was acceptable to be different. For example, one student said, he would "hope I was right and the others were wrong" if he was the only person to hold a particular view. He explained, "You have to think about what you feel inside, not what someone else feels." (S65/I/95b).

Despite the students' claims they were comfortable with holding different views, this did not always seem to be the case. One group of four girls appeared reluctant to record their predictions as to which substances were acids and which were bases. They asked the researcher for her opinion (T6/FN5/95b). Two of them wanted to twink out their predictions when they were not borne out. It appeared the girls were uncomfortable in a situation in which they were either right or wrong. The girls' attitude contrasted with that of a group of five boys. When the researcher sat with their group, they made their own predictions, tested them and recorded the results without comment.

Overall, the six interviewed students placed emphasis on personal understanding which suggested they considered scientific ideas should make personal sense. As one student explained:

I listen to what the others say and then compare theirs with mine. if they are different then I think harder. I might change or I might not. ... it would depend on whether it sounded right. ... I would think about it harder

to see if it added up. I would think about the things I had done.
(S64/L4/95b)

4.2.4 Summary and discussion

This case study provides evidence of the influence of the school setting, in interaction with teacher views (which may be influenced by school policy), on teacher formative assessment practices. The teachers' formative and summative assessment of their students' personal, social and science development as integral to the science unit reflected school policy and their responsibility for student learning across all the curriculum areas. Their strong emphasis on self assessment, both during learning activities and as a summative task, was consistent with school policy and their reported beliefs. Being in a non-specialist classroom had the advantage that the teachers were able to display student work as a source of feedback on what they valued. The disadvantage was a lack of immediate access to specialist science equipment for the provision of empirical evidence as feedback.

The teachers' assessment practices were characterised by their assessment of the students' personal, social and science development and a focus on lesson purpose for their own and their students' self-assessment. Students' personal development related to their ability to self assess and justify their ideas. The students' social development related to the students' ability to work together and share ideas.

The lesson purpose, along with the teacher's feedback and analysis of the students' summative flow diagrams, construed school science as personally meaningful descriptions of what happened. The teachers considered that because of the students' age scientific explanations of why or how something happened were not always necessary. The use of scientific terminology (key words and diagrams) and the ability to justify ideas was used as an indication of learning. The feedback the teachers provided made explicit the extent to which they considered students were meeting their purposes, it emphasised the importance of student self assessment and the development of personally meaningful explanations.

The teachers' actions construed students as active meaning makers and learning as a social activity. This emphasis was reflected in the students' descriptions of assessing their ideas for coherence and their considering it was acceptable for peers to hold different views.

Taken overall, the teachers' and students' comments and actions suggested they viewed learning as movement or progress in student thinking through active meaning making. This indicated they viewed learning as a constructive activity that was socially mediated or supported by interaction with others. Formative assessment was construed as a process that guided this meaning making.

4.3 Case study 2 : Teacher 5

In this case study, the classroom observations and interviews with Teacher 5 and seven of her students are described and discussed. The case study highlights the influence of well established classroom practices and ways of working on teacher and student formative assessment opportunities and actions. It reinforces the notion that teachers assess students' personal, social and science development as an integral aspect of their learning of school science.

4.3.1 The setting

The case study school was a small Year 7 to 13 school. The case study class was a Year 8 (Form 2), intermediate level, class of thirty female students. Teacher 5 taught all curriculum subjects (except technology) to the class in the same classroom. She was responsible for the learning, assessment and reporting programme used in the classroom. This programme included detailed written reporting on the students' science, personal and social development, a focus on student self-assessment and ongoing parent involvement in student learning and assessment (T5/I/95a). (See pp 82 to 83 for a full account of the coding system.)

The topic for the unit was "Our Storehouse Earth". Teacher 5 had planned for the students to learn about the composition of the earth, tectonic plates, the cause of volcanoes, the composition of soil, rock types, how rocks are formed and the use of materials from the earth. She had prepared worksheets to help with this.

Activities for the unit were whole class discussions, six written and two practical tasks. Student interest was stimulated throughout the unit by the eruption of Mt. Ruapehu. Many students and the teacher visited the mountain during the unit and the mountain's ash cloud was often visible.

When the researcher arrived for the first lesson of the unit, the title of the unit and posters and newspaper clippings about earthquakes, volcanoes and oil were displayed on one wall. This display was updated throughout the unit. Other resources for the unit were displayed on a bench in front of the teacher's desk. This positioning maximised her opportunities to observe the students when they used the resources thereby allowing her to assess their skill at working together, something she often found difficult to assess (T5/D2/95b). Students brought

books, photographs and artefacts (photographs, gemstones, necklaces and crystals such as amethyst) from home and added them to the resource table. These items provided the teacher with a robust source of information on student interests and the connections they were making (T5/D3/95b).

Classroom furniture and its arrangement both supported and constrained teacher formative assessment. Student desks were low which facilitated observation as a teacher assessment strategy. The teacher considered her observation of students at work generated robust information because the students "forgot" she was observing them (T5/D2/95b). Five of the seven interviewed students indicated this was not the case. They claimed others worked harder and pretended to understand what they were doing while the teacher observed them. They did not like the teacher to look at their work when it was "half done" because she might "see something you don't want them to see" (S53/I/95b). Their concern may also have been because the teacher used observation as a summative assessment strategy. Students were sensitive about what she might report to their parents (S53,54/I/95b).

Some students limited the teacher's incidental access to their written work by lifting their desk lids (T5/FN2,5,6,8/95b). One student assured the researcher this action was deliberate:

I showed my friend and I quickly put up my desk when she came over so she wouldn't see it. (S53/I/95b)

Students covered their books and talked with their peers in a manner which restricted the teacher's access to their books (T5/FN4,5,7,8,10/95b). However, it seemed it was only the teacher's random access to their unfinished work the students disliked because they showed her their books and asked for her comments and help.

The desk arrangement facilitated peer and self-assessment through discussion, the sharing of resources, and the comparison of written work (T5/FN5-14/95b). Students discussed ideas and then asked the teacher for help or looked at reference books together. They compared book work and then worked harder and changed

or added to their work. The main focus of this assessment appeared to be the quantity (how many pages they had completed) rather than quality of work (S53,58/I/95b; T5/FN12,13/95b).

The time in the school year also influenced teacher and student assessment actions. The teacher stated that as it was the end of the year she had formed a "picture" of the class as a group with well developed listening and questioning skills and individual students as having various levels of confidence, ability to express themselves and typical depth of understanding. The teacher's perception that the students were able to discuss ideas influenced the nature of the learning tasks selected for the unit (T5/D4/95b), and as is evident later, her assessment opportunities and the nature of her feedback (T5/D14/95b).

The seven interviewed students indicated they had formed expectations. They expected the teacher to value certain behaviours and act in particular ways. Their view was illustrated by the student who, when asked how she worked out what teacher considered important, said: "I've sort of got used to what she thinks is important and stuff" (S58/I/95b). Knowledge of the teacher's usual actions was used to interpret her interactions and written feedback (Cameo 4). The students described some of their peers as "bright" and therefore as likely to understand ideas and others as able to be "trusted" not to make fun of them when they asked a question. These perceptions were reported to influence their actions (Cameo 4).

The teacher's planned assessment for the unit was a pre-unit questionnaire and four summative assessment tasks - a knowledge test, a presentation to the class of two of the questions they had explored, a student self-assessment and the marking of student books for content and presentation. The students' presentations took place over the last three weeks of the unit.

A typical lesson

The observed lessons lasted one and a half to two hours. The lessons always began with a whole class activity followed by individual and small group work. During the whole class activity, the students sat on the floor, on a sofa or on chairs in an open space at the front of the classroom. The teacher sat on a low chair within the student group. The discussions lasted for three-quarters-of-an-hour to

an hour. The teacher began the first lesson of the unit with discussion on "Is the earth getting bigger?" based around photographs of ruins she had visited in Rome. Other lessons in the first half of the unit began with the teacher posing a question or, more usually, students talking about the artefacts they had brought from home. The discussions revolved around the layers in rocks and soil, the composition of soil, the colour and texture of rocks, the effect of light and water on the colour of rocks, crystals, gas, the nature of earthquakes, volcanoes and gemstones. The discussions framed (Filer, 1993) school science as linked with the students' interests and experiences. For the final three weeks students presented two questions they had explored to the class as part of their summative assessment.

The students worked on the set tasks and any questions they were interested in during the second half of the lessons. They moved freely around the room, working by themselves, in pairs or groups, looking at resources and sometimes going outside to complete a task. The teacher moved around the room. Sometimes she spent most of the session with one group, sometimes she circulated around the class and talked to most students.

4.3.2 The teacher's views of teaching, learning and assessment

Teacher 5 described learning as an activity that involved individual students "building" on their ideas and as the "growth" of collective or group knowledge. Assessment was described as something done by teachers and students but "on most occasions ... it's a combination of pupil and teacher identifying these things" (T5/I/95a).

The teacher's description of her role as a questioner exemplified her attitude to teacher assessment, she said:

... as a questioner I can generally find out anything I want to find out. ... If you take an interest in what they're doing, they are only too happy to explain and to share. They want to. [The children] enjoy that process and it is good for (them). Children with an idea are given the opportunity to talk about it. If they thought they had a problem, often the solution comes to them as they

talk about it out loud.... the moment they start talking about it "Oh I do know. I can do such and such can't I?" ... (T5/I/95a)

She considered assessment as "something educators need to do to help with the next stage in the children's learning and meeting their needs" (T5/I/95a). For this reason, students were assessed at the beginning of a unit so she could "use what they know and build on that", they were assessed during a unit to find out if the teaching programme was promoting the learning she had planned for and so she could follow-up student ideas. She noted there was "space within my unit to actually shoot off if anybody comes up with an idea" (T5/I/95a).

The teacher stressed assessment was a mutual responsibility. It was her responsibility to provide students with a range of opportunities for displaying what they knew and could do and the students' responsibility to tell her if she was not meeting their needs (T5/D14/95b).

Assessment was also described as a process students needed to engage in for "identifying areas that they need to work on, ... identifying areas they want to work on and accepting areas they need to work on (T5/I/95a). It was one of her long term goals for students to learn to assess themselves as she considered this would enhance "their own personal quality of life" (T5/I/95a). She commented that student self-assessment required her to "shift" some of her power to the students so they could "build up a responsibility" (T5/I/95a).

To summarise, the teacher's comments suggested she saw learning as an activity that involved the individual and the social construction of ideas. Assessment was integral to teaching and learning so that she could use what students "already know" and "build on that" (T5/I/95a). Her description of assessment as a teacher-student responsibility indicated she considered teachers have limited access to student thinking. The importance she placed on student self-assessment (for students now and in the future) suggested she viewed students as active meaning makers. Her comments that students needed to identify what they wanted to work on suggested she viewed motivation as integral to learning.

4.3.3 Formative assessment as identified in the classroom

Teacher formative assessment was accomplished through the use of planned assessment tasks and interaction with students. Both aspects were integrated into teaching/learning. The teacher's assessment focus was on the students' social and personal development as integral to and supportive of their learning of science. Teacher and student formative assessment actions were supported by the mutual expectation that ideas would be shared and respected and the weak boundary that had been constructed between school science and students' everyday experiences.

Formative assessment in the case study classroom is illustrated through three cameos.

Cameo 2: Soil composition

The time when the class discussed soil composition is presented here to illustrate the nature of the teacher's planned formative assessment and the interaction between this and her assessment during interaction. It also illustrates the way formative assessment was integrated with teaching and learning, the influence of the weak frame that had been constructed between school science and the students' and teacher's everyday experiences and the teacher's use of discussion to challenge student alternative conceptions.

At the end of one lesson, Teacher 5 commented that a number of students had an alternative understanding of the composition of soil (T5/D9/95b). She had reached this conclusion by talking with the students and looking at their books during small group work.

She started the next lesson by stating she wished to "Go over a few things" and then asked the students if they could explain why the top layer of soil is darker. When describing the assessment involved in this lesson, the teacher said:

[The assessment was] going over what I found out yesterday. At the end of yesterday I found out that they were confused about land forms and soil. 'Why soil is dark at the top?' So today the assessment was, after using a discussion and having them give examples, asking them 'Is there anyone who still needs further clarification?'. (T5/D10/95b)

The episode was field noted as:

The teacher asked the students: "Why is the top layer of soil darker?". No one responded so she asked who had done some research on soil. Only three students put up their hands. She then stated it was not helpful to wait for others to do the work. One student suggested the soil became sunburnt in the same way people do. This comment was followed by a discussion on burnt cakes, the colour of dry areas, the colour of compost, the top layer of the soil when they were on camp (the class had gone on a class camp earlier in the year) and the colour of damp soil. Twenty students contributed anecdotes from their experiences to this discussion. The teacher also contributed anecdotes on the use of compost in her garden, going on camp and the colour of the soil in the school quad. It was agreed that the top layer of soil was usually darker but no consensus explanation of why emerged. The teacher concluded the discussion by stating "I think we made progress on that question. Are there any questions?". No one replied. (T5/FN10/95b).

This episode illustrates the teacher's typical planned formative assessment. She gathered the initial assessment information by moving around the class and talking to students as part of an ongoing process of assessing their understanding of the concepts in the set tasks. She responded to what she found out by posing a question to the class. This action and the subsequent discussion constituted her formative assessment. In this case, she deferred her action because she had gathered the information at the end of the lesson and because the action she took, of class discussion, usually occurred at the beginning of a lesson. At this time, she told the students of her assessment, that some of them did not have scientifically acceptable concepts of soil, and acted to encourage the students to contribute explanations and ask questions. This action allowed the teacher to gain further understanding of student ideas while simultaneously providing feedback. It utilised the established patterns of discussion for whole class sharing times. The students' immediate contribution of a wide range of ideas suggested they viewed school science as linked to their everyday experiences. The teacher's own contributions during this episode supported this linking. This action was

consistent with the value she placed on students making links with their everyday lives. Of a later class discussion, she commented:

I thought that was quite valuable in that they talked about everyday things while here we were talking in a science lesson. I think quite a few of them ... might have come a bit closer to realising the relevance of what we were talking about to their everyday life. (T5/D18/95b).

The teacher's response was also characteristic in that she introduced soil composition as a topic for discussion on two other occasions. On each occasion, she encouraged students to contribute ideas, indicated to them their explanations were adequate and encouraged them to seek out more information for themselves. The development of the students' ability to conduct research (a personal skill) and share the results of their research with others (a social skill) was one of the teacher's long term goals for student learning (T5/D11/95b). She used this strategy because she considered the sharing of ideas developed understanding:

So one of the things is, it's an organisational thing coming through at the moment, is getting everybody to go and do some research and come back and share. When you actually have to look something up and you have to put it in your own words when you haven't got your notes in front of you ... that is often a way of internalising information. The understanding begins to develop. (T5/D10/95b)

Hence, the teacher's assessment of her students' personal and social development was also linked with her assessment of their science development. This overlap in purposes was also evident when she assessed the students' skill in obtaining information about the formation of mountains from a video (T5/FN11/95b; T5/D11/95b).

The teacher's delay in inputting information until the third occasion the class discussed soil composition (T5/FN13/95b) was consistent with her view the class was an "organism" whose knowledge and interest "grew". She monitored the development of this "collective knowledge" during the discussions at the

beginning of each lesson T5/D8/95b). She explained this action when analysing a discussion of rock types:

This morning we tried to talk on rock types but there was not sufficient knowledge to sustain a conversation therefore I will seek to encourage knowledge in this area and wait until the collective knowledge and interest is great enough before we proceed. ... In this case we will move out sideways and wrap back. (T5/D5/95b)

As a number of students reported to the class on ideas they had explored, for example the nature of alluvial soil (T5/FN4/95b), composition and use of natural gas (T5/FN6/95b), it appeared this approach fostered the view that students were able to contribute to each other's learning.

Another example of the use of planned formative assessment occurred when the teacher noticed some students were uncertain as to what counted as a land form. This episode followed on from the previous discussion on soil composition. It illustrates the variation in the actions taken by the teacher.

Cameo 3: Land forms

One of the set tasks for the unit required the students to draw a map of the landforms in the local area. The teacher noticed some of the students were confused as to what constituted a landform, for example, were lakes and trees landforms? She introduce the nature of landforms as a whole class discussion topic the next day. The researcher field noted the episode thus:

The teacher asked each student in the class to suggest a land form and identified whether or not the student was correct. She elaborated on some local examples, such as Hinuera stone. Next, she checked whether the students considered forests to be a land form. She asked for a number of counter examples. She concluded the session by asking, "Any questions?". The students assured her they understood the idea. (T5/FN10/95b)

This episode was of interest because, in contrast to her actions in Cameo 2: Soil Composition, she acted to clarify the definition of a land form by asking every

student to name a landform and used her authority to publicly evaluate student suggestions. Her evaluation served to confirm for the students that what they suggested was in fact a land form and those listening and waiting to contribute, had an increasing list of land forms to use as a reference for their thinking. In order to evaluate her action, she asked the students to indicate whether or not they had a clearer understanding. However, rather than accepting their assurance that they did she introduced a counter example, a forest. This had been suggested as a land form during a previous class discussion (T5/FN1/95b). When a few students responded "No" to this example, she asked for further counter examples. Only when these were forthcoming did she move on to the next part of the lesson. The teacher commented after the lesson she was still not sure all of the students understood what a land form was. It appeared she appreciated that students are not always willing to publicly state that they do not understand.

Another episode that illustrated the complex, situated nature of formative assessment in this classroom occurred when a student presented her investigation of weathering to the class. This cameo illustrates the teacher's interactive formative assessment, that is her formative assessment that was not specifically planned for but occurred through interaction.

Cameo 4: Expanding and Contracting

The lesson described here occurred near the end of the unit. A student was presenting three short pieces of work to the class as part of her end of unit assessment. On previous occasions, students had chosen to talk about the volcanoes they had made, the soil profiles they had collected, the investigations they had conducted and many other topics. Each day, teacher 5 established who wished to present their work and produced an order for the presentations. The presentation, which led to the events described here, was the third of the day. A student was talking about her investigation of the effect of freezing a piece of wet chalk to simulate weathering. The researcher field noted the event, although she was absent from the classroom when the episode began. When she arrived, the teacher was asking for a show of hands on who thought that metals expanded when heated and who thought otherwise. The episode was field noted as:

Nearly all students indicated they thought substances expand in the cold. A student illustrated this using the metal teeth on bridges.

The teacher asked eight students to move to the corner and to jump up and down. She then asked them if they needed more room and what had happened to their temperature. There was a discussion as to whether this showed substances expand when they are hotter or whether it showed that particles move around more when they are heated.

The teacher encouraged the students to contribute their ideas and experiences and to make sense of all contributions. A student recalled a ball and loop experiment the class had performed the previous year. She explained this as the ring contracting when it was heated. One student suggested that telephone wires sag in the heat. Another said she had been in Christchurch when it was really cold and the wires were sagging then.

The teacher asked for another vote on the issue. All but four of the students voted that substances expand in the cold. The class suggested their previous teacher be asked what happened.

By coincidence their previous teacher arrived and the case study teacher explained the situation to her. The students' previous teacher was obviously surprised at their views. She left.

The discussion continued. One student suggested that it was the water that had expanded not the rock. More students contributed evidence of solids contracting when they cooled. They stated cakes contract as they cool, hair is longer when it is wet, sultanas shrivel as they are dried. The teacher focused the students on the question. More students contributed explanations which suggested the water expanded when the rock was frozen. Other students explained that the ball and ring experiment as the ball expanding when heated.

The teacher concluded the lesson by asking the students what they thought. All but three students indicated they considered cold usually caused solids to contract. (T5/FN15/95b)

This episode was of interest because it illustrated the divergent focus of the teacher's assessment. The topic of expanding and contracting was not a focus of the unit but Teacher 5 assessed that a student and then a large number of students had scientifically unacceptable understandings. Her action of encouraging the students to share and make sense of their experiences was made possible in part because she had the autonomy to extend the lesson to give time for debate. This action drew on and utilised the already established social norms that students would share their ideas and experiences and respect the ideas of others. These norms were such that three students were prepared to disagree with the consensus opinion at the end of the lesson.

The students' immediate contribution of their own experiences was consistent with the weak distinction the teacher had maintained between science and the students' everyday experiences. Presumably, it was also a reflection of the topic. Interestingly, although the students used empirical evidence (albeit recalled) to persuade each other they deferred to the authority of their previous teacher when she arrived. During this episode, the teacher's asking students to share ideas and reach a consensus, along with her action of asking students to model expanding, construed them as thoughtful and having ideas and experiences to offer. It served to represent students as meaning makers, science as linked to their experience, scientific explanations as making sense and consistent with empirical evidence.

The teacher's view of the episode

The researcher and the teacher discussed this episode at the end of the lesson.

R What happened for you this morning?

T I think what happened was, they said weathering. OK it gets really cold and what happens is they see this rock falling apart. And I think that somebody made a jump and said 'It expands'. ... I think somebody made the jump that when things get frozen they end up expanding.

Well, water does expand. But then they immediately leapt to other things. They made a few jumps there and said when the rock gets cold it expands. ... Then somebody mentioned the experiment last year with the ball and the loop and I thought, 'Oh good, they're back on track'. Then they turned around and they explained the experiment and they gave the reverse of the result. That is one of the most obvious experiments we can do for children. We do and it everybody says 'Ahhhhh, yes' and they suddenly relate it to power lines, they relate it to train tracks and they relate it to bridges. In all my years of teaching that has been a logical sequence with that experiment and that idea. And today, it floored me. And it floored Mrs X too. I saw the look on her face. ... Prior to her coming in they said 'We'll ask Mrs X', and they were convinced that she was going to back up what they were saying. (T5/D15/95b)

The teacher described the episode as one in which she had encouraged the class to deconstruct the idea of expansion and contraction:

Is that what you call deconstructing? Breaking it down and finding out what the bits are. What bits have we got? I think the bits were all there but they just had them in the wrong order. So we had to take the concept apart and see what is was we were trying to find out. (T5/D15/95b)

And then to reach a consensus:

I'd given some sort of clue as to what we were going to do. We were going to have to agree on something and it was either this or that. Nothing in between. (T5/D15/95b)

Confidence in her (i) understanding of the science, (ii) pedagogical skills and (iii) knowledge of the students played an important role in her spontaneous action. She was confident she understood the science as "there is no doubt about .. what heat will do to metals". She was confident, based on her experience of teaching the topic (her pedagogical content knowledge), that the students would have everyday experiences to share:

I know there are lots of really good examples and I felt sure we could bring those example to light and the kids would be convinced. ... It is an everyday thing, expansion. (T5/D15/95b)

Her choice of action was influenced by her confidence the class had the skills to reach a consensus and would recognise she intended them to do so:

I have confidence that I and they have developed certain skills and patterns. I think they recognise this technique of discussing around. I don't say 'No' to someone. I say 'Ummm' and I go onto the next person. That indicates to children 'Well that person might have had an idea, but it was a bit deep, it was a bit hidden, or they weren't on the right track'. But who knows. So I go onto the next person to see if they can give something. It maybe critical, in that the technique may not be an option if you don't know your class. It is something you have got to develop. (T5/D15/95b)

And, that she had the skills to help the students "agree on something". Even so, her confidence in her understanding and her communication skills wavered during the discussion when the class had seemed "absolutely adamant they were right". This prompted her to question her own understanding and communication skills:

"Have I got it wrong?" or "Have I got it right but what I'm saying is wrong?" at this time. So that it was right in my mind but what was coming out of my mouth was wrong. (T5/D15/95b)

Teacher 5 indicated she had been surprised by the thinking of some of the students suggesting she was influenced by her knowledge of them:

Well, there was assessment in that it was great to know L didn't let me down and my assessment of her is correct. I was a bit stunned at J being on the fence and E begin on totally the wrong track. ... (T5/D15/95b)

She reported she was satisfied that all but three students understood the ideas of expanding and contracting at the end of the lesson.

Student perceptions of the episode

This episode was discussed with two students, who entered the room while the researcher was talking with the teacher immediately after the lesson and with six students a day later. The two students said their knowledge of the teacher's usual actions and reactions had confused them during the discussion. They associated sustained teacher questioning with them not being "on the right track". They told the teacher:

S51 I thought it was a bit strange because you kept asking questions.

S59 And you didn't go "Yeah, that's right" or anything.

S51 This is strange, but I'm sure I'm right.

T5 Yes, is that a technique that I use, that when people aren't on the right Track, I keep asking questions. But when people are on the right track, I don't.

S59 You don't say much.

S51 You don't go like this, "Ooh right, and what do you think?".

S59 And like if it's right, you'll say "Aahhh". (T5/D15/95b)

The six students interviewed the next day were ambivalent about whether the discussion had contributed to their understanding. Four said they had become "mixed up". Their view was illustrated by the student who said:

... well I got a bit mixed up with that hot and cold thing. Which got bigger? I thought that the power lines actually drooped when it was cold, but it's the other way around. And I didn't actually realise that liquid and um, solids are two different reactions. (S54/I/95b)

However, they stated it was important to share ideas and that eventually the discussion had resolved their confusion.

Student comments (and reactions) indicated they attributed their teachers with the authority to legitimate answers as right. They would have preferred the teacher to exercise her authority sooner as one student explained:

I think I wouldn't have been confused if X [the teacher] had said like, told us the answer. Then I wouldn't have got confused. (S54/I/95b).

Teacher body language was reported as able to legitimate ideas. One student reported it could have influenced the whole discussion, she said:

If T's face had gone [the student raised her eyebrows]..... as we'd started the discussion we would have all changed our minds straight away. But she didn't. (S51/I/95b).

Their previous teacher's reaction to their assertion solids expand with the cold had been crucial in "convincing" them this was not so. A representative comment was:

At the start when I said that the cold makes it expand it kind-of felt, sounded funny. I thought 'Oh', but I just kept saying it until I convinced myself that I was right. I then unconvinced myself when I saw Mrs X's face. (S54/1/95b)

In this case, the student ignored her intuition the answer was wrong and was persuaded by the consensus view and then by the teacher as an authority on science.

The students indicated some students were attributed with an authority commensurate with that of a teacher. In this episode they claimed that if, "L", a student they (and the teacher) considered to be bright, had given the correct answer early in the discussion "everyone would have agreed with her" and the debate would not have ensued (S51,59/I/95b).

Recalled empirical evidence was also reported as influential. One student said a peer recalling snow on the telephone wires near Christchurch had been particularly persuasive. She explained:

B said "I remember when I was in the South Island and it snowed heavily and the power lines were really down low. It was really cold". That swayed or slightly convinced me because I thought, "No, she wouldn't forget it, if

they were down there, they were down there. It isn't something you make up or forget" (S51/I/95b).

They also identified the ball and ring experiment from the previous year as influential although it appeared that they had "remembered the experiment quite clearly" but forgotten "which way around it was" (S51/I/95b).

The students were emphatic they needed to "find out whether the ideas are right or not". They identified teachers, text and empirical evidence as having the authority - being trustworthy enough - to do this as was illustrated by two students who said:

S56 You have to eventually either read a book or do an experiment to find out. Because otherwise you just have a whole lot of different ideas from different people.

S55 And you don't know what was right. (S55,56/I/95b)

Another point of interest in this episode was that the teacher and students spoke of the discussion in terms of their ideas moving along a path or track. The teacher reported her intention had been to "find out where this path may led and we'll make it come back to where we need it to be". She had been surprised E was "on totally the wrong track". It had been critical that she understood what the students were thinking and "where we have got to get to" - the scientific explanation of expanding. The challenge had been to "figure out a pathway there". She noted the pathway had "come right back to where we started but rather than to see expansion as with cold seeing it with water".

4.3.4 Summary and discussion

Formative assessment in the case study was shaped by the learning activities and assessment practices utilised by Teacher 5. These in turn, were influenced by the time of the year, the topic of the unit and the nature of the classroom. The teacher's formative assessment focus was on the students' social, personal and science development and included, for example, the ability to listen and share ideas, to manage the time and undertake research and student understanding of the curriculum she intended them to learn and the understandings and interests they

were developing. She assessed the social aspects of student learning as both a valued individual goal and as a support for student learning. The teacher formatively assessed and responded to student learning in science referenced ways through the use of planned tasks and when she interacted with students while they were working on the set tasks. She sometimes followed up her assessment through interaction by posing a question to the whole class for discussion at the beginning of a lesson. That is, her planned formative assessment and her formative assessment through interaction during learning (her interactive formative assessment) informed each other.

The unhurried nature of the teacher's management of the unit activities, made possible by her autonomy and the institutional setting, seemed to be important. The teacher revisited the same idea on a number of occasions, she encouraged students to think about and find out about ideas. These actions were consistent with the teacher's view that collective knowledge grows within a class. They construed understanding as something that takes time and students as members of a community of learners who were able to contribute to development of collective understanding and coherent explanations.

The weak frame the whole class discussions constructed between school science and student's everyday knowledge and experiences, provided the teacher with a rich source of information on student interests and the links they were making. The discussions provided students with feedback on what counted as school science and the standing of their own ideas

Assessment was shaped by and shaped teacher and student expectations that ideas would be shared and respected. Teacher 5 utilised students' ability to discuss ideas to encourage them to contribute ideas and experiences to develop consensual explanations when they were confused or held scientifically unacceptable explanations (Cameo 4). These expectations supported student disclosure to the extent that three students were prepared to publicly state they disagreed with the consensus view of the effect of cold on solids. In this way, the teacher's assessment practices construed school science as the coherent explanation of empirical evidence with the students being seen as able to develop these

explanations through debate and negotiation. The students indicated they considered themselves in this way. One student explained:

We were talking in the car, because we're in a car pool, and S51 said that it's a proven fact that children learn more if they find out for themselves. (S57/I/95b).

The students were active in the formative assessment process. They assessed their own and each other's book work and sought help and advice about ideas and how to do tasks from peers and the teacher. These actions were consistent with the teacher's view that by the end of the year students should share the responsibility for their assessment. However, the students' responses in the discussion about the effect of cold on solids indicated this had been only partially successful.

Although the teacher guided them towards a consensus view they were persuaded by the authority of their previous teacher and peers they considered knowledgeable to the extent they reconceptualised practical results in contradiction to their own sense of what might happen.

A striking feature of the case study was the similarity between the students' and the teacher's perception of what was learned. The teacher considered the students were beginning to appreciate the links between school science and their lives and develop more "specific" understandings of geological phenomena (T5/D12/95b). The seven interviewed students agreed, one student said that whereas previously she known what land forms were now she understood how they were formed (S51/I/95b). Another said she had known about rocks and weathering but not the different types of rocks (S54/I/95b). A third said she had known there were tectonic plates but not what they were (S53/I/95b). The students said they had found out about things they had previously taken-for-granted and now found fascinating (S51-57/I/95b).

The teacher's and students' views of learning and assessment were also similar. The teacher's comments indicated she viewed learning as movement along a path or track towards a predetermined destination. It seemed she tolerated divergent pathways for student learning and that her assessment was aimed at guiding the students towards her destination (the science) over time. The students also

considered the teacher kept them “on track” during discussions. A representative student description of the unit was:

We had discussions and we kind of, she [the teacher] said that, like put up your hand for ideas and if we went off track she'd make sure that before we left the discussion we were on track, sort of thing. (S51/I/95b)

Thus it appeared the teacher and students viewed school learning as purposeful but not strictly controlled by the teacher so that students were active participants in learning and its formative assessment as a situated social activity.

To summarise, the teacher formatively assessed the students through the use of planned tasks and by interacting with them. These two forms of formative assessment interacted and informed each other. She made science criterion referenced interpretations of the student actions and interactions. She responded to student views by using her authority to legitimate some ideas and by encouraging students to research topics, to recall and use empirical evidence and to discuss ideas. Thus, her formative assessment was generally consistent with her stated view of assessment and her actions contributed to a view of school science as sensible explanations consistent with empirical evidence and linked with student experience. The teacher's formative assessment both supported and depended on students being able to contribute to each other's learning and students as being able to make sense of events through discussion. Overall, it supported a view of learning as a social process embedded in interaction that involved individual and collective meaning making.

4.4 Case study 3: Teacher 8

In this case study, the observations and interviews with Teacher 8 and 23 of her students are set out. The case study highlights the dynamic nature of teacher interactive formative assessment purposes and the influence of these purposes on student perceptions of the purposes for and meanings of task engagement. It also illustrates the impact of a strong teacher focus on student motivation.

4.4.1 The setting

The case study school was a large co-educational Year 9 to 13 school and the case study class was a mixed ability Year 10 class. Teacher 8 taught the observed class for three lessons per week. The lessons took place in a room designated as a science laboratory. The students sat at grouped tables during written work and worked at benches around the outside of the classroom during practical work.

The observed unit was called "Sight and Sound". During the unit the students completed series of practical activities and watched a video. The teacher used two planned summative assessment tasks: a knowledge test and the production of a pamphlet on the use of light or sound in a everyday device.

A typical lesson

The lessons followed a pattern. The teacher introduced the activity for the lesson, answered questions about it and then the students worked on the activity in a group of three to five. While they were doing this, the teacher moved systematically around the room and talked with them. She spoke to each group at least twice. Students also approached her for help. Towards the end of each lesson the teacher reminded the students to record their results in their books and checked that they had. She tended not to sum up the lesson with the whole class.

4.4.2 The teacher's views of teaching, learning and assessment

Over the period of the study (1995-1996), the teacher emphasised that assessment should "benefit" students. By this, she appeared to mean that assessment, like her teaching, should focus on the "whole person" and acknowledge and value "the many skills that the kids actually learn in the classroom" (T8/I/95a). (See pp. 82

to 83 for full details of the coding system.) She considered this focus to be consistent with the emphasis in the "new" science curriculum (Ministry of Education, 1993b). She was concerned that "traditional" assessment methods focused on knowledge alone and undermined student self esteem:

The way I see the way we're sort of doing assessment at the moment is you do a test and you mark them and a lot of it's knowledge. And a lot of the kids don't do well and their self-esteem goes down. (T8/I/95a)

The teacher construed learning as intertwined with student self esteem, persistence and enjoyment (T8/I/95a). For instance, practical work was described as a particularly effective learning activity because "the students enjoyed it, got more out of it" and therefore "the knowledge will come" (T8/I/95a). She indicated that assessment to support student self-esteem overlapped with assessment for social management. For example, "positive reinforcement" was said to encourage students to consider "their results could be right" (to encourage students to consider themselves as competent) and "to build on good behaviour" (T8/I/95a).

The teacher described her role as teacher as that of a "support or resource person who let them [the students] go to it" (T8/D6,7/96). Formative assessment was described as the process she used to find out where students "were at" (locating their understanding) in relation to her curriculum goals and to provide "guidance" about where students might "move to next". She explained:

Assessment is a guideline for a whole group of people to know where that person's at. Especially for the student to know where they're at." (T8/I/95a).

She maintained it was important students were involved in assessment so that they too knew "where their starting point is, where they can go and where their weaknesses are" (T8/I/95a). She also commented that teachers needed to assess students so they could provide information about student understanding to the Education Review Office and parents as part of being accountable for student learning.

In summary, it was the teacher's view that assessment should benefit students. To this end, she asserted it should support student motivation and self-esteem as well as learning. She described her role as teacher as that of a resource or support person with formative assessment as process that allowed her to guide student learning.

4.4.3 Formative assessment as identified in the classroom

The teacher's formative assessment was embedded in and accomplished through her interactions with students while they were engaged in learning activities. (She used no planned formative assessment tasks during the observed unit.) Her interactive formative assessment was characterised by a focus on ensuring the students completed the set activities, actions to support positive student motivation and self esteem, a focus on social control and the provision of student-referenced feedback. The following cameo is representative of the teacher's formative assessment practices.

Cameo 5: Using a light kit

The activity for the lesson required the students to investigate how lenses, mirrors and prisms influence the path of light. The researcher field noted the episode:

The teacher began the lesson by reviewing the investigations the students had conducted during the previous 4 lessons. Next, she explained the purpose of the activity for the day was to "Look at how light travels". The teacher showed the students the three slits, plane, concave and convex mirrors, the glass blocks and prisms and the concave and convex lenses they would use to do this and handed out a worksheet titled "To find out how light is reflected, refracted and absorbed". Using a series of closed questions and answers the teacher focused the students on what happens when light is reflected, the difference between concave and convex lenses and mirrors, the meaning of refraction and absorption and how to use the equipment safely.

The teacher handed out the equipment and the students started working. She systematically moved around the groups and checked all the equipment

worked and encouraged the students to experiment with the equipment.

When she next spoke to each group she asked: "What have you found out now?". The third time she spoke with the groups she asked whether light was being reflected, refracted or absorbed in their current set-up and then encouraged the students to begin the activities on the worksheet.

The students got out the worksheet and looked at what was required. They had to record the path of the light rays through a series of lenses and prisms. The teacher moved around the groups again and asked to see what they were recording. She asked a number of students if they could draw "more exactly where it (the light) goes" pointing to the angle the light rays entered and exited the glass blocks. She asked some groups what happened to the light when it was inside the lenses. In many cases she and the students set up the equipment while they were discussing her questions.

A group of students approached the teacher and said they had finished the task. She checked their books and handed them another sheet with a further activity.

Most of the students were writing in their books. The teacher continued to move around the room and talk with the students about what they were recording. She asked what happened to the light rays while they were inside the objects. Another group approached her and asked for the "extension" activity.

The teacher asked the students to pack up the equipment and the lesson ended. (T8/FN6/96)

This episode was of interest because it illustrated how the teacher's formative assessment focus evolved during a lesson. The researcher considered the teacher's decision to encourage the students to experiment with the equipment and the timing of her action to focus them on the requirements of the set task were crucial to the success of the lesson. The students hadn't used the equipment before and they were eager to do so. The students experimenting with the equipment provided the teacher with rich information on student learning. The teacher's use

of the question "What have you found out now?" to elicit information when she interacted with a group construed the students as having been thoughtfully engaged in the task. This appeared to support students' sharing of their findings.

The teacher provided the students with science and student referenced feedback on their science understandings during the lesson. She used her authority as teacher to confirm whether light was reflected, refracted and absorbed. She suggested the students set up the equipment and repeat the observations if their written record of the path of light through the various lenses and mirrors was inaccurate. She modelled productive actions to do this. (Her modelling of possible actions, rather than directing the students to work in a particular way, was a common feedback action (T8/FN4,8,10/96). The teacher also provided student-referenced feedback. For example, she suggested to a student who did part time fashion modelling that she use these observation skills to observe more closely the path of light rays through a lens (T8/FN6/96; T8/D6/96). In this instance the teacher's action was intended to enhance the student's self esteem and to ensure she developed a positive view of herself as being able to do and make sense of science (T8/D6/96). Her provision of extension activities was also student referenced. She knew some students could be expected to complete tasks quickly (T8/FN3,4,6,7,8/96).

The teacher reported that her checking of student books at the end of the lesson was a check on student learning. She described bookwork as "a record of where they're at ... and ... if they can use new ideas or new concepts and put them into practice" (T8/EOY/96). However, it appeared to have a number of functions. It is possible that her checking of books was due to five to eight students not bringing their books to class and that it was a response to a school policy that students should bring their own books to class. Whatever the case, the teacher's assessment of bookwork appeared to communicate to the students that having books was important. When she gave them an informal test more students seemed concerned about not having books that the fact that they were being tested. In addition, the students asserted, and the teacher agreed, she checked student books to check the students had been working (SG84/L5/96) thereby suggesting that her checking of books also served a management role.

Student perceptions of the episode

The impact of the teacher's formative assessment on the students' perceptions of the purposes for engagement in tasks is illustrated by this cameo. Prior to this lesson, the interviewed students had reported the purpose of their completing lesson activities was to have "fun" and to be "busy". On this occasion, their comments indicated they had adopted the teacher's purpose for the lesson was that the students were to appreciate "What happens to light when it hits various objects" (T8/D6/96). For example, one student said:

We just had to draw the shape in and what ... the light does when it goes through the um, shape. (SG83/L6/96)

Another said he had learned different shapes made "light go in different angles" (SG84/L6/96). A third student said the lesson had been about how different mirrors and lenses "can change its paths". The students said they had worked out what was important from what the teacher had asked them to do or re-do and what she said they were doing successfully:

She looked at our work and she said "Oh, you haven't filled this in" or "You haven't done that properly". And we thought, we'll go back to other people, "What are we supposed to do?". And they tell us and we show her and it's right. (SG84/L6/96)

The researcher field-noted that this group had asked the teacher about the orientation of the prisms and lenses and the teacher had looked at and discussed their diagrams with them.

However, it appeared that the teacher's feedback led the students to focus on what happened not why - on the path of light through a lens not the fact that light travels in straight lines. After the lesson the teacher speculated whether the students appreciated this:

They had three straight lines, and they haven't thought about it yet, they're drawing it, but I don't think they're actually thinking about it, and light is

travelling in straight lines. But they know that when light hits something, it's one of three things happen to it. (T8/D6/96)

None of the students discussed the notion that light travels or that it travels in straight lines during the interviews. The teacher had not introduced this as the idea underlying the activities (T8/FN6/96; T8/D6/96). As she commented after the test on light the class had "covered all the ideas which are in the test but we have not talked about them." (T8/D5/96).

4.4.4 Summary and discussion

This case provides an example of interactive teacher formative assessment. Teacher 8 moved systematically around the room and talked with the students while they were engaged in learning activities. The students reported they appreciated the opportunity to talk with the teacher. They considered this was the only way she could find out about their learning (SG83/L4/96; SG82/13,4/96).

The teacher's actions were generally consistent with the value she placed on student motivation and self-esteem and her view of the relationship between these factors and student learning. Her science-referenced interpretations and science and student-referenced actions helped the students develop their ideas (about light). Her care-referenced actions sought to maintain and enhance the relationship between students and science (Noddings, 1995). Her care-referenced actions included, for example, her encouraging the students to experiment with the ray box equipment before she focused them on the set task, her use of questions that construed students as having been engaged in the set task and her use of student-referenced feedback. The teacher indicated her feedback also deliberately served simultaneous learning and management functions. For example, after a lesson on pin hole cameras, she commented it was important students engaged in and perceived the set task as worthwhile so that they both learned from the activity themselves and did not disrupt others (T8/FN4/96, T8/D4/96).

Although the teacher identified student motivation as important, it is also possible her focus on motivation was influenced by the nature of the class. The

composition of the class had changed throughout the year (T8/D2,3/96) and attendance varied from day to day (T8/FN1-8/96). Eight of the interviewed students identified the motivation to attend class as a learning issue. The students claimed their peers stayed away if they didn't enjoy classes or consider them worthwhile. One student explained: "You can't learn if you don't come to school" (S87/2/96). However, the students' comments indicated they often thought the purpose for their doing activities was to have fun or to be busy. It seemed the teacher's focus on task completion, enjoyment and motivation construed school science as experience (of practical work) rather than the development of an explanation of how or why something happened.

The teacher's focus on individuals and sensitivity to student self esteem and motivation appeared to contribute to her positive relationship with the students and to enhance the information she had access to. The students were eager to share what they found out with her. They sought out her help and asked her questions while they were working on the set tasks thereby providing her with a rich source of information on their thinking. Even a student whom the teacher sent to the withdrawal room for week because of unsafe behaviour said he enjoyed coming to class. He considered the teacher wanted the class to enjoy the lessons.

The students' actions indicated that the mutual recognition of the goals of a learning experience and shared criteria for judging success are important if students are to act on teacher feedback. For instance, one student reported to the researcher that he didn't care that his recording of the flame test for copper as yellow was incorrect. He was satisfied to have completed the task (SG82/L5/96). The influence of teacher formative assessment (the information she gathered and the focus of her feedback) even informal assessment on students' perception of these goals was surprising (Cameo 5).

To summarise, the teacher formatively assessed the students through interaction with them. Her practices reflected her view that assessment should support student effort and motivation and that these factors enhanced learning. Student perceptions of the purposes of task engagement appeared to be influenced by both the nature and focus of the teacher's formative assessment.

4.5 Case study 4: Teacher 3

In this case study, the observations and interviews with Teacher 3 and nine of his students are described and discussed. The case study provides further examples of formative assessment as a planned activity (planned formative assessment) and as an activity that occurs during interaction (interactive formative assessment). It illustrates the effect of a strong, almost exclusive, teacher formative focus on whether students are developing the intended science understandings. Student comments suggested this formative assessment approach is experienced differently by different students.

4.5.1 The setting

The case study school was a large co-educational Year 9 to 13 school. There were 25 students in the class which was a mixed ability Year 10 (Form 4) class. The observed lessons took place in a science laboratory which was the teacher's usual teaching space. The teacher had easy access to a well equipped "prep-room" which contained a wide range of equipment that he had built or collected. This equipment formed the basis of his teacher demonstrations.

The student benches were arranged in three columns. This facilitated the teacher's access to students during practical work and to student books during written work (T3/FN1-17/96). (See pp 82 to 83 for a full account of the coding system.)

The topic for the unit was "Electricity" and as such, within the teacher's specialist domain. The unit involved the study of cells, circuits, fuses, electromagnets and electric power.

The teacher stated that, by time of the study (June to August), he had built up "pictures" of the class as a whole and of individuals in it (T3/D3,4/96; T3/EOY/95). He made special mention of one student, J. J's impact on the teacher's access to student thinking and his perception of whether the class understood ideas is discussed in section 4.5.3.

A typical lesson

Each lesson began with the teacher marking the roll. He then read out 5-8 prepared questions. For example, over the unit he asked:

What is the difference between a cell and a battery?

How can we make a cell?

Draw the symbol for a light

Draw a 3 cell battery connected to 2 lamps in series

What do amps measure?

Name 3 things which have an electromagnet in them

When current flows through resistance wire, what happens?

(T3/FN2-12/96)

The students answered these in the back of their books. While he was reading out the questions he moved around the room, talked to the students, checked they had their books and read what they were writing. Some students asked him questions, others talked quietly with each other. Once the questions were completed, the teacher asked for volunteers to suggest answers. Over time, more students volunteered to do this, particularly to draw circuit diagrams on the board. Students offered a range of answers and the teacher legitimated some of them. For example, he accepted "the number of elections", "current", "the flow of electrons" as answers to the question "What do amps measure?" but said "electrons" alone was not correct (T3/FN10/96). The students marked their own work. The teacher assigned marks to the questions and asked for a show of hands as an indication of how many the students had correct. After this, if students told him they did not understand, he referred them to their notes. Students near the back sometimes responded "I still don't understand" to this suggestion (FN3,4,8,10,11,13/96).

Next, the teacher introduced the topic for the day. The notes, demonstrations and practical activities for the lesson were written out on overhead transparencies. The students copied these into their books. The lessons always included a teacher demonstration and / or student practical work. The teacher used a wide range of equipment, including everyday equipment, to illustrate the ideas from the unit. The lessons concluded with the students copying a conclusion into their books.

4.5.2 The teacher's views of teaching, learning and assessment

The teacher described learning in terms of ideas "sticking" (T3/TR/96) and students "latching on" (T3/I/95a; T3/D4/96), "taking in" (T3/TR/96) and "getting or picking up" (T3/I/95b) ideas. He described teaching as "building on" and "shifting" student views (T3/I/95b, T3/EOY/96). Formative assessment was described as "intertwined with teaching" (T3/I/95a) for the purpose of "finding out where the kids are at" in relation to what he intended them to learn (T3/I/95b) so he could modify his teaching to "fit in with the kids":

Assessing is finding out ... whether they're coping with the concepts, understanding the concepts that we're hoping to present them with ... On the basis of what you find out as you assess the kids you modify your teaching somewhat to fit in with the kids. (T3/I/95a)

However, he did not expect all students to understand the ideas in a unit and considered this "may not matter too much" because they would meet the same ideas at a later stage (T3/TR/96).

Teacher 3 considered formative assessment helped teachers meet students at a "human level" which was important because "if you don't relate to them, you've lost them" (T3/EOY/95b).

He considered caregivers and the community expected teachers to be able to provide information on student learning (T3/I/95a). However, his emphasis on assessment for reporting purposes appeared to be shaped by the school ethos - the other teacher from the school also emphasised this aspect (T8/D4/96).

The teacher also noted that student feedback affected teachers:

The other thing that is important is that we have feelings, as kids have feelings and if a kid ... treats you in a way which is inappropriate, you're less likely to feel inclined to sit down and help them (T3/EOY/96)

In summary, the teacher's comments suggested he was concerned that students acquire the knowledge outlined in the curriculum and his assessment was directed towards finding out if this was the case and modifying his teaching if it was not. He did not expect all his students to do this during a particular unit.

4.5.3 Formative assessment as identified in the classroom

The teacher formatively assessed his students through planned questioning at the beginning of each lesson and by interacting with them during practical work and teacher demonstrations. His assessment was characterised a focus on the curriculum; whether the students had learned what he intended. The impact of this focus is illustrated through two cameos. The nature and impact of the teacher's planned formative assessment is described first.

Cameo 6: Planned formative assessment through quick questions

As described in section 4.5.1, each lesson began with the teacher asking 5-8 prepared questions. This generated information in the form of written answers. The teacher talked with the students while they were recording their answers thereby adding to the information he had access to. Student answers and questions during the question review provided him with further information. For example, a student asked if an electric cell required a pink and a silver metal suggesting the student was focusing on colour rather than different metals (T3/D3/96). Another student asked whether the symbol for a cell had to be drawn in a particular way (T3/FN4/96; T3/D4/96).

The teacher's view of the questions

The teacher viewed the questions as his planned formative assessment for a lesson. He explained:

Walking around and looking at what the kids have done, especially some of the girls, in the short test gives me a good chance to see if they've ... learned that sort of thing. ... by designing the lesson that way it gives me a chance to see how the kids have gone and, perhaps, pick up on where kids are not coping. ... I could pick up ... the girls here had coped ... they understood series and parallel. (T3/D9/96)

At the end of the unit, the teacher reported that student achievement in the summative test was generally congruent (within 10%) with what he had predicted based on performance in the questions and "involvement in discussion, listening, attentiveness" (T3/TR/96). He commented that it was interesting that "you can rank the kids without a test and get it basically right with one or two who surprise you" (T3/TR/96). It seems probable that the match occurred because the questions he posed at the beginning of each lesson and were similar to those in the test.

It was the teacher's view that by re-presenting certain ideas in the questions he communicated to the students what it was important to learn (for the summative test). This action utilised the classroom norm that if something is assessed then it is important. He explained:

The fact that you're focusing on certain aspects and asking specific questions will direct the kids to areas that they think you see as important. ... that they should know or learn and which will come up in the summative test. (T3/EOY/96; T3/TR/96)

The teacher saw the answer review time as serving to "bring more kids on board" (T3/TR/96) because ideas were re-explained but in a slightly differently way. He described the process of repeated questioning and explaining as "hammering" the ideas into the students' heads until they "stuck". Over the unit, more students indicated they were scoring higher marks on the questions suggesting the activity did serve this function.

He considered the students assessed their answers by comparing them with those he legitimated by asking themselves: "Have I got the right answer?", "Is mine different or the same?" (T3/EOY/96). It was not possible to determine if this was the case but a number of students asked the teacher if alternative answers were acceptable indicating this was what they were doing.

Student perceptions of the question time

Student perceptions of the formative function of the questions varied. All nine of the interviewed students confirmed they saw a link between what was in the quick questions and what was important. They expected what was covered in the questions to be in the end of unit test thereby supporting the teacher's contention that re-presentation of and assessment of ideas communicated that an idea was important (to the teacher).

Three students described question time as helpful in confirming if their ideas were right or wrong. A representative comment was:

It [the questions] gets my mind into it. ... it's fun to me. You get marks for them. Um, the teacher calls some people out to see if they got under this certain number. He's trying to make people excited ... I think they're helpful and help people to know if they're right or wrong. (SG33/L12/96)

In contrast, three students said they had "Failed every one of them" (SG36/2/96) because they were not "in the mood of thinking science" when they arrived to class. They viewed the tests as "batting" ideas into their heads (SG32/L10/96). They also questioned the effectiveness of referring them to their notes when they did not understand an answer. It seemed that although this response utilised the culture of classrooms and society in using the status of the written word, not all the students were able or willing to use the information they had recorded.

The question-and-answer sessions highlighted the need for the teacher and students to share the same language. On three occasions, some of the students appeared to misinterpret the teacher's questions. For instance, four students responded to the question "How do you wire up a voltmeter?" with "We used wires". The teacher gave the answer as "In parallel" without further comment. On five occasions the teacher's use of science criterion referencing appeared to hinder his understanding of student answers.

On five occasions the teacher's use of science criterion referencing appeared to hinder his understanding of student answers.

Cameo 7: The fuse

A representative example of the effect of the teacher's focus on the science he intended the students to learn occurred when the teacher asked "What does a fuse do?". This incident was field noted:

The teacher named a student to answer the question "What does a fuse do?". Initially, the student was reluctant to do so but the teacher persuaded him. The student said, "A fuse is used to light a bomb". The teacher did not comment on his reply but sought other responses. Another student suggested fuses were used to break an electrical circuit. The teacher then talked about using fuses to prevent electrical fires in houses and moved on to the next question in the quick test. (T3/FN9/96).

After the lesson the teacher said to the researcher he had "picked up" during the test that the student had written fuses are used "To make a bomb go" and been puzzled by this. When the researcher suggested the student may have been thinking about a bomb from an action movie he said:

Oh, of course, fuse. Oh, yes. I never of thought of that. ... Yes, it's a different sort of fuse, isn't it? ... A bomb fuse or a firework fuse. ... I had a mind set on electrical fuses. ... although I suppose I used to use fuses and fuse boxes to set off flashes for stage shows years ago. (T3/D9/96)

In this case, as the teacher commented, his frame of reference was science and so, in the moment, he was unable to interpret the student's answer. (T3/D9/96)

The second aspect of the teacher's formative assessment was his assessment of the students while they were engaged in a practical work or watching a demonstration. Two cameos of formative assessment at this time are presented

next. The first, which took place during a demonstration illustrates the teachers focus on students completing and understanding the ideas as he intended.

Cameo 8: Planning

This cameo documents the influence of meticulous planning on the teacher's formative assessment during the introduction of the idea of electric power (T3/FN15/96). The teacher introduced this idea by (i) demonstrating the differing brightness of two bulbs of the same size, (ii) discussing where students might have seen light bulbs and what they had noticed about them, (iii) discussing the differences in the wattage of bulbs, (iv) asking the students to consider why people bought bulbs with different wattages, and (v) using a meter to demonstrate that a glowing bulb uses energy. He used two bulbs of a similar size but very different wattages (15 and 650W) in the first demonstration. When he asked the students what they had noticed, a student sitting at the front of the class said, "They've got different watts". The teacher ignored this comment and repeated the question until a student said, "The bulbs have different brightness".

After the lesson, the teacher explained his plan for the lesson had been "fairly well set". He had used his prior experience of teaching the notion of power, to prepare the lesson and deliberately used two bulbs of similar size to focus the students on the difference in brightness. He explained why he had not appropriated the student's answer thus:

All I wanted for that was different brightness. I not did want a detailed answer about energy but just the trivial 'One's brighter than the other.'

It seemed the teacher responded to the formative assessment information he obtained on student ideas by planning and preparation for the class rather than by responding to the immediate sense being made by individual students. That is, his interactive formative assessment influenced his teaching of the same subject to another class in another year. This reduced the uncertainty in the learning situation for him but his convergent focus appeared to be interpreted by a number of students as a lack of interest in them and their learning as is illustrated by the next cameo.

Three groups were observed on the second day of this episode. It was field noted as:

The first group (two girls) began the task by debating who would collect the equipment. Eventually one of them collected a coil, a power pack and a bulb. They then asked the researcher what to do. She reminded them the teacher had said they would need some wires. The teacher approached their bench and they told him they didn't have any wires. He sent one student to collect some, gave them three, told them to wire up the circuit drawn on the board and took the spare wires away. The students wired up the power pack and the coil. They added the bulb at the researcher's suggestion. When they turned on the power nothing happened. They checked the connections and called the teacher over. He replaced the power pack fuse, checked the circuit worked and suggested the students test the electromagnet. The students touched a paper clip to the middle and near the end of the coil, noted it "stuck", checked that this was all they had to do and turned off the power.

The teacher did not interact with the second group of two boys. Their circuit appeared to be a tangle of wires and the bulb did not glow. They asked J, a student they described as "brainy", for help (SG33/L12/96). He looked at their circuit, said it was a "mess", re-wired it and tested it to see if the electromagnet worked. Later in the period the researcher noted the two boys were lifting up strings of paper clips.

The third group, which included J, collected the required equipment and wired-up the circuit very quickly. The group experimented with how many paper clips the electromagnet could pick up. When the teacher talked with them he encouraged them to do this and asked how they thought the electromagnet worked. J explained the "electric current produces a magnetic effect". They set about breaking the "world record" for picking up paper clips by experimenting with different numbers of turns and currents. (T3/FN10/96)

The students' view of the episode

The first group reported the purpose of the activity was "just testing some light or something" (SG32/L10/96). This group indicated they were not very interested in and had very little prior experience with circuits. They interacted with each other and the teacher to get the circuit to work and claimed the activity, which required them to follow a sequence of steps, made them feel like "robots":

S36 He told us to go off and use this as how you do it. ... He drew up the picture of how, of what to link to where and the power pack and all that.

S37 Well, I think he should let us explore it more.

S36 In small groups, like hands on with the power pack and the things. ... Because when we first started, we sort of had a bit of free time, you know, OK, try this, try and work out how to get these two lights to go.

S37 Yeah, that was good like that.

S36 Cause then you remember it. Like if he just tells you do this, you just do it.

S37 It's just like you're a robot. He programmed you to do something.
(SG32/L10/96)

This impression was enhanced because that was what "always" happened.

By way of contrast, the second group, although they also appeared to have very little prior experience, did not interact with the teacher. Their recognition and use of another student's prior knowledge limited the teacher's access to their lack of understanding.

The third group, which included J, engaged with the science embedded in the task. The teacher challenged them to explore the properties of electromagnets - to develop their science understanding - rather than to simply complete the task which these students experienced as open and engaging. They told the researcher they liked science, enjoyed the practical work and came to the lessons to learn more (SG31/L3/96). However, it seemed that not all of the group necessarily understood the ideas. After a lesson in which they wired up a circuit for a light bulb one student asked what a "circuit" was. J explained this to him in terms of a

racing circuit. The student had appeared to the researcher to be involved in and to understand the task and so this example highlighted the dangers of inferring that task completion indicated understanding and of generalising understanding from the comments of one or two students.

The third group of students served as "target students" for teacher formative assessment and often appeared to limit the teacher's appreciation of whether the class understood ideas. The target students arrived early and appeared interested and knowledgeable. They answered questions when students at the back were quietly saying they did not understand. The teacher viewed this as an indicator of understanding (T3/EOY/95). Five of the nine interviewed students (those not in the target group) claimed the teacher assumed most students understood an idea when the target students indicated they did. Two students commented on the influence of the "brainy kids" thus:

... all the brainy kids who are at the front, you know are interested in that sort of thing, I think he takes their, you know, response as an 'I understand'.
(SG32/L10/96)

The comments of those students not in the target group further highlighted (See Cameo 7) the need for teachers and students to share a common language. They asserted that "big words" contributed to a lack of mutual understanding. They explained:

S36 X's always using big words and we have no idea what he's talking about.

S37 But like.

S36 They [teachers] need to be able to communicate with the students on a level that the student's at.

S37 Both people understand. You know, students understand, teachers understand, the teachers understand what the students, you know, are talking about and trying, teachers understand if the students you know, are not learning. (SG32/L10/96)

S37 Both people understand. You know, students understand, teachers understand, the teachers understand what the students, you know, are talking about and trying, teachers understand if the students you know, are not learning. (SG32/L10/96)

These students also raised as an issue the need for teachers to take on trust that student questions were genuine. They claimed the case study teacher sometimes responded to questions by asking "What are you talking about?" and then saying: " Oh, that. Oh that means that, don't you know, you silly people?" (SG32/L10/96). They illustrated this claim by describing an incident that was observed by the researcher (T3/FN9/96). They said:

S36 Electrons. At the end of the lesson did you hear A go, cause he said, he said, I want you to find um, three electric movements or something, and um, A, "What's electric movement?".

S37 What's electro magnet sir? And he didn't even answer his question, he sort of ignores questions like that. It's just like, he thinks they're being silly, but they're not. They seriously don't know what he's talking about. (SG32/L10/96)

On this occasion the teacher did appear to ignore the student's question. It is possible his action was influenced by A's apparent lack of involvement during the lesson and by A's tendency to come to class without a pen or a book as he indicated "inappropriate" behaviour influenced his motivation to help students (see section 4.5.2). It is possible the teacher's actions derived from his perception not all students will understand ideas (See section 4.5.2). It is also possible his actions were influenced by the need to clear up and prepare for the next class. Whatever was the case, it appeared the student's query was a genuine one as he discussed it with his peers as he left the room (T3/FN9/96). If this was so, then this incident illustrates the importance of taking on trust the authenticity of student questions.

The teacher's planned formative assessment practice of posing questions and answering questions at the beginning of each lesson construed formative assessment as a teacher controlled assessment activity separate from teaching and learning. This practice required overt student participation and was a variation on the "initiate, respond, evaluate" sequence commonly found in classrooms (Mehan, 1979). All students were required to respond in writing and the teacher assessed their answers but only a few volunteers answered publicly. As the questions converged on what the teacher had taught, they served to frame valued school science as knowledge prescribed by the teacher. Moreover, the closed nature of the questions construed important scientific knowledge as fixed and discrete. The repetition of questions construed learning school science as the acquisition of facts facilitated by repeated exposure or memorisation as was evident in comments by the teacher and students that the activity hammered the ideas into students.

A view of school science as fixed facts was reinforced by the teacher's suggestion that students read their notes if they did not understand ideas. Here the teacher used the authority of text as a source of persuasion. As he did not have understanding as a short-term goal for each student and he knew he would be revisiting ideas the next day, it seemed he did not feel obliged to help each student understand before he moved on. A view of school science as facts was reinforced by the tight control the teacher maintained over student bookwork through formative assessment at the beginning and end of each lesson. Even though the teacher took care to use everyday equipment, his use of teacher demonstrations and the sequenced practical activities construed school science as an activity teachers and not students engage in.

The teacher's formative assessment during demonstrations and practical work was integrated with teaching and learning and hence less visible. A feature of this assessment was that the teacher tended to respond to student ideas through planning between lessons rather than to individuals in the moment. This action was consistent with the teacher's description of formative assessment as an activity for informing teaching. It supported his curriculum science focus and reduced the uncertainty of the situation for him, however it frustrated a number of students. They interpreted his lack of immediate response to their professed lack

assessment was that the teacher tended to respond to student ideas through planning between lessons rather than to individuals in the moment. This action was consistent with the teacher's description of formative assessment as an activity for informing teaching. It supported his curriculum science focus and reduced the uncertainty of the situation for him, however it frustrated a number of students. They interpreted his lack of immediate response to their professed lack of understanding as a lack care of and concern for them and their understanding. It appeared that although the teacher put considerable effort into planning and preparation his effort was only appreciated by students with a strong background in electronics. This perception contrasted with the teacher's view that teachers needed to meet students at a personal level and that he was responding to their needs. Overall, the teacher's strong focus on science appeared to privilege students who had relevant prior knowledge so that the students experienced learning and assessment as having had different social, emotional and cognitive consequences.

The teacher's focus on science may be seen to explain the influence of a group of five boys on his assessment of the class's understanding. The five students shared the teacher's language and it seemed the teacher concluded the class understood ideas when this group did. It may be crucial that the teacher viewed factors such as interest and sensible questions as evidence of understanding. These students indicated they enjoyed coming to class. They came intending to learn science. Their formative interactions with the teacher were about science ideas. In contrast, students who appeared to lack the relevant prior knowledge and interest claimed they felt like robots with the formative assessment hammering ideas into their heads. They interacted with the teacher to complete tasks. A lack of a shared language between these students and the teacher inhibited the ability of both to interpret questions and answers.

To summarise, the case study illustrates the impact of a convergent teacher formative focus on the science in the curriculum to highlight how this contributes to diverse student perceptions and experiences of learning and the formative assessment of it.

4.6 Case study 5: Teacher 9

In this case study, the observations and interviews with Teacher 9 and eight of her students are analysed. The focus is on the match and mismatch between teacher and student perceptions of teacher formative assessment. It provides further examples of planned and interactive teacher formative assessment.

4.6.1 The setting

The class was an able group of twenty nine Year 10 (Form 4) girls from a small all-girls school. The teacher held a senior position in the school.

The observed unit - An introduction to Year 10 Science - was the first of the year. It began with a one hour pre-test that was not observed. During the unit, the students revised safety in the laboratory, measurement techniques, the use of controls in experiments and how to conduct a scientific investigation. The unit was intended by the school to revise the scientific ideas and skills considered essential for the successful completion of Year 10. It was not one the teacher would have chosen to teach. She considered it fragmented and decontextualised the ideas (T9/D1/96). The first four lessons of a unit called "Home Comforts" were observed a month later.

The lessons took place in a room designated as a science laboratory. The set up of the student tables gave the teacher easy access to students when they were writing and doing practical work.

During the period of the observations the teacher and the interviewed students reported they were "sussing" each other out. After the first lesson the teacher said she had evaluated the students' thinking and interaction skills, attitudes and science knowledge. She needed this knowledge so she could plan her teaching to take into account what the students knew and to get them "really thinking". She commented:

It is the beginning of the year and I need to know they know the safety rules and what they recall from Form 3 so they are ready to tackle the next bit ... I want to get them involved and really thinking. To do this I wanted to find

out where the talent lies. ... Who are the good plodders, who are the lateral thinkers and what are the class group dynamics. (T9/D1/96)

The interviewed students volunteered they had assessed the teacher. This was in response to a question about the teacher's assessment of them. They explained:

S95 In a way I kind of assessed X (the teacher). It was ... the first lesson where we actually did something and ... it was interesting to see how she was going to go about it and talk to us.

S94 I was just kind of sussing out ... how far you could go with.

S96 And what her limit was.

S95 If she was prepared to explain it again to you and not just say it once.
That's it.

S94 And to treat the class all ... the same ... not certain people.

S96 Get certain treatment or.

S96 Or this one is really bright so she gets special attention and this one is quite dumb so.

S94 "I won't waste my time with her", sort of.

S95 But that didn't happen. (SG91/L3/96)

The teacher's likely reactions were of interest to the students because teachers sometimes responded to requests for help by "shouting" or "growling" at them (SG91/L3,5/96; SG92/L4,6/96). These reactions were of concern because they were considered to influence how their peers viewed them.

The teacher was aware of the students' assessment. She considered they compared her actions and the activities she used with those they had experienced in previous years. She explained:

The class are formatively assessing me every lesson we've had. The situation they're in, the environment ... If you are looking at formative assessment how can you ignore the students' assessment? ... of the teaching situation, the teacher, the environment. They compare it with last year. Do

we have as much gear available? Have you delivered it in a way they are interested in? (T9/D5/96)

She considered the students assessed so they could "give" her what she wanted:

They pick up where they think the teachers are at ... they give the teacher the response they think they want ... still we are into, "This is a new teacher, give her what she wants" (T9/D1/96)

A typical lesson

The students engaged in a variety of activities including whole class discussion, practical work and written work. Teacher 9 began each lesson by stating her learning purpose. During the first few lessons she emphasised she wanted the students to think rather than focus on being "right" (T9/FN1,2,3/96). Lessons concluded with the teacher restating her learning goals for the lesson and outlining her assessment of student achievement of these.

4.6.2 The teacher's views of teaching, learning and assessment

Learning was described by the teacher as a "non-linear process that involves making of new links with prior knowledge and acquiring, transferring and linking new ideas". For this reason, she considered formative assessment to be "hard" and "difficult" (T9/I/95a). Formative assessment was said to allow her to "model" her teaching to "respond to what the students are actually taking out of whatever situation you're putting them in" (T9/EOY/96). The metaphor she used for this process was that of an "orchestrator":

It comes back to, rather than a delivery, a feedback. All the time being aware. So you are not a deliverer, but you are an orchestrator. You notice when it's time to wave the violins in or whatever. It comes back to sensitivity to the students thinking (T9/D9/96).

Formative assessment was also said to enable her to take into account where the students considered their learning was going:

There's formative assessment. It is matching in my head where I think they're going and where I think, they think they're going, too. (T9/D9/96)

The teacher commented on the importance of affect in learning - both her own and the students' (T9/I/95a). She contended information on whether the students were "tired, stressed, bored, doing something else or not able to focus" was needed so she knew "what and how to teach" (T5/EOY/95). To this end, effective teaching and assessment for better learning was considered to require teachers to know their students as people and to know the subject and how to "put the two together" (T9/I/95b). She explained:

... If you don't know the person, how do you know what and how to teach them. ... in assessment for better learning ... probably the first layer is you know your students. The second layer is know your subject and the third layer is know how to put the two together. So you've got to assess your students on an informal level so you know who you're teaching to and with. But then you also need to know your subject so you know what you want them to learn and then you have to be able to .. [marry the two] (T9/EOY/95)

Teacher 9 stated she also used formative assessment to "set expectations" (T9/I/95a). This use of formative assessment derived from her view that students saw positive feedback on a particular idea or action as an indication that "this is important" (T9/EOY/96).

In review, the teacher saw assessment as a tool for finding out what her students felt, knew and could do and what they might do next and for responding to this. She saw it as both informing her teaching and helping her to get to know her students as people as part of the process of linking them into her "agenda" for learning science. Her contention that different students "moved to a different point" (developed different understandings) as a result of participation in the same activity indicated she considered learning as a constructive activity.

4.6.3 Formative assessment as identified in the classroom

The teacher planned to assess the students at the beginning of the unit and at the beginning of some lessons to do this. She also assessed the students by interacting with them. Two cameos are presented in this section to illustrate how she integrated formative assessment into the teaching and learning activities of a lesson and then an episode which a student identified as involving her assessment is set out to contrast teacher and student perceptions.

Cameo 10: Orbitals

A representative episode of the teacher's planned formative assessment occurred when she formatively assessed the students' understanding of the notion of orbitals. She took this action in response to feedback she had gathered during the previous lesson (T9/D10/96). The researcher field noted this episode as:

The teacher told the class her lesson purpose was to review the structure of atoms to "lay the basic ground work" for the next unit which was "Chemicals in the home". She briefly reviewed the pattern for arranging electrons in shells around the nucleus and the tendency of different atoms to form ions. Next, she asked the students to draw the electron shells for three elements. She wrote on the board:

The atomic number of lithium is

Draw a lithium atom

How many electrons are in the outer shell?

Repeat for magnesium and chlorine.

One student asked, "How am I supposed to know the atomic number of lithium?". The teacher told her to use the periodic table. Another student said:

I was not here on Friday so I don't understand. I don't get this.

The teacher replied that on Friday the class had worked through the example of sodium. She recapped on the form of the nucleus, the electron shells and how the number of electrons in the outer shell is linked to the reactivity of an element. The student asked:

How do we know how many electrons are in the shells?

The teacher explained the shells filled in the order 2,8,8. The student then asked: "Is that for every single one?" and later "Why is there are only 3?". The teacher concluded this interaction by asking: "Is there anyone else who was not here on Friday or was here on Friday, who did not get it?". She received no response.

She moved around the classroom talking to the students.

The teacher walked past S who called her back, explained what she understood and asked for confirmation that her interpretation was correct. The teacher looked at her drawings with her and then moved on.

The teacher moved to the front of the classroom. Said, "Some students are drawing the middle like the outside ... remember it is like the earth and the others are satellites". She then began the next stage of the lesson.
(T9/FN10/96)

This episode illustrated a number of aspects of the teacher's planned formative assessment. Firstly, she used the planned task to follow up on information she had gained during the previous lesson. Secondly, the assessment task doubled as a learning activity and so the assessment was integrated into the teaching and learning. Furthermore, the activity elicited written information on the thinking of all students in the class (each student produced their own diagrams) although the students worked on the activity in pairs or groups. The teacher supplemented this information by talking privately with the students. This also allowed her to provide immediate individualised feedback. When an action was successful with individuals she repeated it with the class.

The teacher's view of the episode

Teacher 9 said her intention in using the task was to assess the students by "looking at the things they should have learned in doing the drawings" (T9/D10/96). The responses she "expected" served as pre-determined science

referenced criteria which she used to interpret student drawings. She described her assessment thus:

I've got two pieces of assessment done. One, how the whole class had taken them on [the idea of electron shells] and two, the specific problems that a few people were having which let me tell the whole class a couple of things (T9/D10/96).

The dual focus on individuals and the class was a theme in the teacher's comments. She experienced as a dilemma her responsibility for the progress of the class through the prescribed content and her responsibility for fostering individual understanding. She asked herself the question "What is enough?" in relation to what percentage of the class should understand an idea before she moved on to the next one (T9/EOY/95). She revisited ideas in order to address this dilemma (T9/EOY/95; T9/D5/96; T9/D9/96) although she reported the efficacy of this action was limited by the students' expectation they would make progress through the content or at least to be doing different activities each day:

... they're expecting you to make a progression through time in what you're doing. So you can't stay on one thing even though they may not have understood it. (T9/EOY/95)

The integration of the teacher's planned formative assessment with the teaching and learning that is evident in this episode was important to the teacher. This was highlighted for her when she analysed an attempt to use a planned formative task during a lesson. On this occasion, she identified a learning outcome she anticipated being able to teach in "three different ways" (T9/D10/96) and planned a task to assess it. She reported her intention to use a specific task had constrained both her teaching and her usual style of ongoing formative assessment:

Having set a piece of formative assessment and a task that I thought would generate some good formative assessment material felt different in the sense that the lesson was then, ... we often talk about whole courses being tailored by assessment ... the lesson was tailored in a sense by that bit of formative assessment I wanted to do. ... I didn't want to do something and then stop

and say now, "Oh, by the way, I thought we just might do this because it's a useful thing to do". ... to me, it had to be part of the flow. Therefore, it clouded my thinking quite a bit, because no matter where they were and where I was, there was this other thing ... I've got three things in the juggling and I can only handle two. I've got myself and the students and the material that we're normally working on. I've added another dimension ... at this particular point in time. There's a checkpoint. Now I can hang on to the checkpoint and say, I'll use it next lesson, which is what I actually ended up doing. But I had an agenda today that I'd try and fit it in. I thought when I looked at it and planned it that it would fit ... and it still didn't feel like I wanted to. ... The piece of assessment I had in mind involved simple grouping and organising. It felt to me if I did that to them on top of what they'd just been doing, you'd get total confusion. (T9/D10/96)

Thus, it appeared the assessment task had constrained her action because she was attempting to use it during the lesson rather than at the beginning which was her usual practice. This episode confirmed for her that formative assessment needed to "complement what and how she was teaching and what and how the students were learning" and therefore needed to arise out of teaching and learning rather than be "imposed" on it (T9/D10/96). She commented this approach required teachers "to have the strategy sufficiently on board so that with the people in front of you, you can not only think of the strategy, but you can do it" (T9/D10/96).

The students' view of the episode

None of the six students interviewed after the lesson identified the episode as a time of assessment, rather, they reported the teacher had helped them understand orbitals. One student said of the activity:

I found out quite a bit about the periodic table and things like that. It was quite helpful also because the teacher did take time out and she didn't seem to mind at all. (SG91/L10/96)

The student who spoke to the teacher said of the incident:

S95 I was away on Friday, but the teacher still took time out to explain to me. Clarified it all so I know what I am doing now.

Res. ... What did the teacher do that was particularly helpful?

S95 She drew diagrams on the board and she didn't seem like "Ohhh, I don't know, S95 doesn't know". She just did it on the board again and then she came back and she showed me. And she came and did one of the experiments with me and showed me how to do that properly, and things like that. Came and did it in my book with me and made sure I was doing it right in my book. (SG91/L10/96)

The teacher's willingness to re-explain orbitals was important to this student. Previously, she had said she wanted teachers to respond to her questions by "not treating you like you are stupid but just explaining over again" (SG91/L3,5/96). She assessed Teacher 9 to see "If she was prepared to explain it again and not just say it once" (SG91/L3/96) and so she viewed the teacher's action very favourably.

More generally, the interviewed students indicated a willingness to revisit ideas served to communicate to them that the teacher thought understanding science ideas was both important and possible. In response to the question "What do you think the teacher thinks is important?" they said:

S95 Making sure we understand things. Having work completed.

S94 Making it clear for us.

S95 She's doesn't really mind how many times she has to go over things.

S96 She'll go over it many times.

S97 She had to go over mass and weight last lesson. Nobody got it so she did it again this lesson.

S95 I think that is good.

S94 Because if you don't understand.

S96 There's not much point coming to class (SG92/L7/96)

It is possible the impact of a willingness to revisit ideas derived from the students' experience that teachers asked if they understood ideas, found out they did not and "moved on" anyway. They explained:

- S96 They [teachers] are in such a hurry.
- S95 You don't want move on because you still don't understand it, you don't understand the first thing.
- S96 They think "We are running out of time, we have to finish this thing" so they do that but it .. would help if you knew the first thing
- S95 You don't want to move on. (SG91/L5/96)

Thus, it seemed the teacher's formative feedback not only clarified the notion of orbitals but also communicated that understanding was important to her.

The teacher also formatively assessed the students' personal, social and science development when she interacted with them during learning activities. This process required her to notice student comments, questions and actions, recognise the significance of these in terms of the science understandings she was hoping to promote and respond. This process often occurred in a moment and at a tacit level so that the aspects influenced and mutually informed each other in a contextualised manner. A cameo of this process of interactive formative assessment is outlined next. This episode was selected because it was representative of the responsiveness of the teacher's formative assessment.

Cameo 11: Washing powders

At the beginning of a lesson Teacher 9 provided the students with a set of statements about types of washing powder and washing conditions. They were to select those which would allow them to set up a control experiment to test the claim: "Sprite washes cleanest in cold water and better than any powder cleaners if used in hot water". After she had introduced the activity she moved around the class and talked with the students. When she spoke to S94 and S95 she asked them to explain why they had selected a particular set of conditions.

This episode was of interest because the teacher had intended the exercise "to check through really quickly" that the student knew what a scientific control was. Her active formative assessment had begun when she couldn't understand student comments in the whole class situation. The students' responses had not "matched" what she expected (T9/D4/96) and so she had moved to one-to-one interaction to obtain more information. On seeing the students' answers the teacher realised

there were a variety of ways of interpreting the task. She redefined the criteria for student understanding of the notion of control from that of there being a particular answer to students being able to justify their answer (T9/D4/96). She reported that finding a number of students with different ideas had been crucial to her redefining her criteria. She explained:

Yes it is [important more than one student has the same idea]. Because you can process one and say I'll come back to it. But you process three and say this needs to be addressed as a group and you get to five and you say, 'OK, let's do this for the whole lot. I do that quite a lot because I'll be going around a class, and I'll say hang on, I think we all need to stop at this point because there's obviously something here that we need to go through. (T9/EOY/96)

The teacher's redefined criteria for evidence of an understanding of control (her short term goal) fell within the framework of her long term goal of promoting "deep thinking" (T9/FN1,2/96). This action was typical of her response. She also redefined her criteria from the "best method" to "different methods" (T9/D3/96) when the students designed a test to determine the number of colours in black ink.

Two students were interviewed after the sprite activity. They reported the teacher had assessed them but described different teacher actions as indicating this. One student associated the teacher's assessment with the provision of feedback. She said the teacher had said their answers were "another two ways [of answering the question] that she had never heard of". The other student reported the teacher had "asked questions, just make sure, to make us explain it to her as if she didn't understand" (S95/2/96). That is, one student identified teacher assessment with receiving feedback and the other with having her ideas elicited. Both students appreciated being told "we'd done it right" and having their originality valued.

Taken together, Cameos 10 and 11 highlight differences in the subtlety of the assessment process. It appeared the students did not identify the first episode as an occasion the teacher had assessed them because their own and the teacher's interactive focus was on helping them understand the notion of orbitals. In

contrast, it appeared they identified the second episode as assessment because the teacher elicited their ideas and provided them with feedback.

The next cameo further illustrates the nature of student perceptions of teacher formative assessment.

Cameo 12: Measuring

The students were asked to determine which of six containers had the greatest volume as part of a revision of measurement skills (T9/FN4/96). As soon as the students began work on the activity one of the interviewed students approached the teacher and asked her a question. The teacher stopped the class and repeated the instructions. The student described the episode thus:

S96 I went up and asked her something and that's when she told the class she was assessing us.

Res Tell me more please.

S96 I .. went up to her and asked her exactly what we had to do because the thing about measuring the 6 cups and measuring the water wasn't very clear to me. I didn't know exactly what to do so I went up and asked her. She stopped the whole class just because of my problems. I didn't feel that great because I was right beside her. (SG91/L4/96)

Neither the researcher nor the two other students at the interview could recall this episode but the researcher found it in her field notes. The student said the teacher's response had made her uncomfortable:

S96 ... I asked her and then she sort of said "Whole class stop", and I just turned around and everyone was looking at the teacher and I was standing right beside her.

Res. Do teachers quite often do that?

S's Yes/ yes / yes.

Res. Is that OK?

S96 Well it's not because it just my problem, not necessarily everyone's.

S95 Just sometimes if they stop and say "Does anyone else have a problem with this, can you come over here".

S96 That would be better, heaps better. (SG91/L4/96)

The student would have found the response acceptable if the teacher had made a positive comment, otherwise her peers concluded she didn't understand and could make fun of her:

S94 If she said "That was such a great comment you made J", while you were standing up there then it won't matter so much ... but otherwise everyone would go "Oh, you don't know that".

Res. Do people do that?

S's Yes.

S94 It is not always like that ... sometimes they are just joking.

S95 Sometimes people laugh afterwards. (SG91/L4/96)

This teacher action may have had special significance for this student. On a previous occasion she had stated she would like more positive public recognition of her thinking (SG91/L5/96).

This episode highlighted differences in teacher and student perceptions. The teacher considered responding to the class provided information to all the students, including those who were not prepared to ask questions and whom she had not had the opportunity to assess (T9/D8/96). In contrast, the student focused on the fact that the teacher had disclosed her lack of understanding to her peers, thereby placing her in a position of potential harm. The students claimed the possibility of this happening caused them to restrict the questions they asked (see section 5.4).

4.6.4 Summary and Discussion

This case study highlights the influence of the teacher and student knowledge of each other on their formative assessment opportunities and actions. At the beginning of the year, the students were concerned to find out what the teacher considered important and how she reacted to questions and interacted with them. The teacher was concerned to get to know how the students thought and worked together so that her teaching built on and was responsive to this. She was

conscious of the students' assessment and deliberately used formative feedback to communicate her expectations (of deep thinking), thereby portraying formative assessment as involving the exchange of information.

The teacher's formative assessment was integrated into the teaching and learning activities of a lesson in a manner consistent with her view that formative assessment should arise out of and complement teaching and learning.

The teacher's formative assessment practices were characterised by responsiveness to student ideas. She revisited ideas and revised the criteria for successful task completion and/or understanding. The use of pre-determined and emergent science criterion-referencing allowed her to incorporate student ideas into a lesson, thereby communicating and supporting her long term goal of fostering student thinking within the framework of her short term goals for activities. It was not possible to determine if this responsiveness was her usual practice or due to her lack of commitment to the aims of the first unit. Whatever the case, her willingness to revisit ideas was a significant factor in how the students came to perceive what was important to her. It construed understanding as a valued goal and students as thoughtful and active meaning makers.

Another characteristic of the teacher's practice was that she attributed students with "good will". That is, she assumed they were "focused on getting where you want them to be" (T9/EOY/96). This meant she not only interpreted their comments using science referenced criteria she also tried to understand why they were having difficulty and how her own actions might have contributed to this. For example, when two students approached her during the third lesson on the idea of a control to tell her they did not understand the idea she reviewed the lessons for why this might be the case (T9/D4/96). Student comments indicated that such responses simultaneously communicated that she was concerned with their understanding and reduced the risks of disclosing their ideas (See section 5.4).

The case study provides evidence that students are aware and active participants in formative assessment. The students sought help when they did not understand ideas. They described some teacher actions as having been involved with their

assessment although teacher and student perceptions of these were not necessarily the same. They indicated that they did not appreciate teachers disclosing their ideas to others without their consent even when the teacher's intention was to help.

To summarise, this case study provides further examples of teacher formative assessment using planned tasks and interaction. It supports the view there is a relationship between teacher views of learning, teaching and assessment and their assessment practices. It also highlights that students are active and aware participants in formative assessment.

4.7 Case study 6: Teacher 7

In this case study, the classroom observations and interviews with Teacher 7 and seven of her students are described and discussed. The main focus of the case study is the influence of teacher assessment purpose on student participation in the assessment process. The students indicated they were reluctant to participate in interactions they perceived as involving their summative assessment. It provides further examples of planned and interactive teacher formative assessment.

4.7.1 The setting

The class was an able Year 9 (Form 3) class, in a large co-educational secondary school. All twelve lessons from a unit on "Hot Air Balloons" and the last two lessons of a unit on chemistry were observed. The hot air balloon unit began with a visit by a group of balloonists who brought in and inflated a balloon and explained how it worked. The students recorded their views about how hot air balloons work in the next lesson. They spent two lessons completing five investigations covering the ideas of density, floating and sinking, one lesson on each of reviewing the results of these investigations, linking the ideas of hot air balloons with floating, sinking and density, discussing the design of hot air balloons and explaining why different substances floated at different levels in a column. The final four lessons were spent designing, making and test flying a small hot air balloon as the school's summative assessment task for the unit.

A typical lesson

The lessons included a range of activities including assessment tasks, practical work and discussion. They followed no set pattern but were focused around the notion of density.

4.7.2 The teacher's views of teaching, learning and assessment

The teacher described learning as a process of "building up" ideas and assessment as a process for finding out where students were "at" at the beginning of a unit, of "seeing" what sense they were making during the unit and finding out what they knew at the end. She explained:

We assess to find out where they're at and assess things as they're going to find out where the loopholes are and what things they've grasped and what things they still have not got and at the end a total. (T7/I/95a)

Formative assessment involved a comparison of the sense students were making of an activity with what she thought they would learn so she could “model” her teaching to respond to this:

When we've done experiments and things [assessment is] just seeing what they got out of it and how that relates to what I thought they would get out of it. And quite often they're different ... it is important to model the way you teach to ... the way that they're grasping it [because] there's no point in moving on unless they've got something. (T7/I/95a)

Her learning purposes for the lesson served as a “sieve” that filtered out what “relates to what I'm trying to achieve that lesson” from all the information available within the classroom. (T7/I/96)

In summary, the teacher expected students to construct different understandings from their engagement in activities and she assessed them to determine the sense they had made so she could model her teaching to this.

4.7.3 Formative assessment as identified in the classroom

Teacher 7 planned formative assessment tasks to elicit information on the students' "before-views" and developing understandings of the notion of density. She also interacted with them to find out the sense they were making of activities. Her assessment was characterised by a focus on the scientific notion of density but she acted in care-referenced ways to maintain her relationship with the students and their interest in science. Her formative assessment is illustrated through three cameos.

This first cameo presents an episode that occurred during the last lesson of a unit on chemistry. It illustrates the student-referenced nature of the teacher's interactive formative assessment.

Cameo 13: Separating salt and sand

During the second observed lesson, the teacher asked the students to separate a mixture of salt and sand. Most students did this by dissolving, filtering and then evaporating the mixture. One student requested tweezers. Teacher 7 discussed the viability of this strategy with him, and provided him with tweezers. He sorted the crystals and then asked for a magnet. Later, she questioned him about the composition of the pile of white grains he had produced (T7/FN2/96). This student concluded his strategy would not work 10 minutes into the next lesson and dissolved the white mixture he had produced (T7/FN3/96)

The teacher's action in this episode was representative of her response to student ideas. She acted in a science criterion-referenced way to encourage the student to test out his own ideas knowing they would not be completely successful. Her action was also student-referenced because she considered the student was unlikely to be persuaded by unilateral statements (T7/D2/96).

The students appreciated the fact that the teacher did not "put down" their ideas. They reported she usually provided them with suggestions:

S74 She never, like, if you give an answer, she never puts it down and says "You're a bit off track there".

S76 What she has done to me before is say "I understand that bit but this bit here, I understand, but can you explain it for me.

S's Yes

S74 And if you can't then she just gives you another way of doing it.
(SG71/L9/96)

The students contended these suggestions for were helpful because they were able to incorporate them into their own ideas (SG71/L10/96). Suggestions were said to "kept them thinking" (SG72/L9/96) indicating that they sought to make sense of their experiences. Suggestions appeared to communicate respect. Mutual respect was described as fundamental to effective interaction with teachers by one group. They explained:

S74 I think it all comes down to respect. How much you give them and how much they give you.

S76 If you ... respect them then they will give you [respect].
(SG71/L5/96)

The students also appreciated individualised feedback. One group described how the teacher talked to the table in front of them using scientific words and to them in “plain English”. They said:

S75 ... the table in front of us, they are all ... quite scientific, they all know words so she can go and talk to them "The solution of blah, blah, given blah, blah, blah" but when she comes to us she has to say all the.
S76 She talks to us in English, plain English. (SG72/L6/96)

Individualised feedback was also said to communicate teacher concern for them and their understanding.

The next cameo illustrates the interaction between the teacher's formative actions with individuals and with the class.

Cameo 14: Mixtures

This cameo was used in Chapter One to introduce this study. During the lesson the teacher assessed that her students did not understand how to separate substances such as broad and kidney beans, oil and water, iron and gold, and salt and sand because they were not familiar with their properties. She acted to provide them with this experience.

After the lesson, the teacher expressed surprise that the students did not have a "general knowledge" of the substances she had chosen for them to separate. She said:

It became obvious that they didn't actually know enough about these things to be able to separate them. ... there were quite a lot [of students] who didn't know what oil did. To me it was obvious it was going to float [on water]

but it wasn't to them because they didn't have the experience of that.
(T7/D1/96)

She reported student questions like "What on earth are kidney beans like?", "What does oil do?" and "What will oil do if you filter it?" (T7/FN1/96; T7/D1/96) had triggered her awareness of student thinking. She noted it was significant that more than one student had asked these questions.

She explained her action in providing the students with experiences of the substances thus:

I had to show them what oil did when you put it on paper. Because they didn't realise it would soak in. ... they wanted to know if it would go through or if it would sit on the top. (T7/D1/96)

Her acting with the group who asked the original question, and when the action appeared effective, with the class as a whole was deliberate. She viewed the students who asked the questions as "thoughtful", that is she expected them to understand ideas, and so she anticipated other students would be having difficulty with the activity. Her action with the class was intended to provide feedback to these students and to students who "do not like to display their uncertainty to the teacher" (T7/D2/96). Thus, this action was an attempt to compensate for the limited access she had to student ideas.

As the teacher commented, her formative assessment "required" her to review both her lesson purposes and her the time frame for these. She had intended to discuss how the substances could be separated and only to separate salt and water. On finding out the students' prior knowledge, her goal became one of increasing the students' knowledge of the individual properties of the substances she wanted them to separate and of the relevance of these to the mixture. In addition to responding immediately, she began the next lesson by demonstrating the separation of oil and water, the students then separated meths and water and sand and iron filings. She also demonstrated the non-magnetic nature of gold.

During the continuation of this episode on the third day the teacher also followed up a student comment that was not a direct focus for the unit. The students had implied they thought that the oil-water boundary of an oil and water mixture would be parallel to the sides of the container if it was tilted. She demonstrated this was not the case and discussed why at the beginning of the next lesson (T7/FN3/96). Thus, within this episode Teacher 7 acted to address the students' scientifically unacceptable conceptions by revisiting the task requirements, providing the students with practical experiences and following up on alternative understanding that were not directly her focus for the unit.

The next cameo illustrates the influence of teacher assessment purpose on student participation.

Cameo 15: Density and the tower

In this cameo two episodes are compared and contrasted. The concept of density was the focus of both episodes. The first episode is described in the section called "Density". It illustrates the processes of planned and interactive formative assessment. The second episode is described in the section "The tower" and is more summative in nature. The two episodes are compared and contrasted in the third section of the cameo.

Density

The episode described here took a whole lesson. The teacher's intention was to discuss the notion of density. The researcher field noted the lesson thus:

The teacher started the lesson by reminding the students they had started to talk about density during the previous lesson. She asked someone to tell her what it was. A student said it was "mass or volume". The teacher rephrased this as: "It is mass or the mass of a certain volume?". She emphasised that the certain volume was important and recorded on the board:

$$\text{density} = \text{mass of a certain volume}$$

She asked the students how they thought density, floating and sinking were linked. No one answered. She reminded them of the experiment in which

they checked to see if cubes of different materials floated or sank. A student sitting beside her spoke to her. The teacher said:

T Z has a thought. Z?

Z All those which weighed less than water floated and all those which weighted more than water sank.

The teacher restated Z's idea and asked if anyone could put it in a sentence using density. A student said:

S Whether or not something floats depends on it density

The teacher asked if someone could provide another phrase which "tells us a little bit more?". A student discussed lead floating and sinking. The teacher asked for a general statement. A student offered:

S Things which are more dense than water sink and things that are less dense float.

The teacher asked the class:

T Does that make sense to you all? If not put your hands up.

There were nods and "Yeahs" around the room and she wrote on the board:

To compare the weight of materials we must use a fair test.

J gave the formula $\text{density} = \text{mass}/\text{volume}$.

She continued writing on the board:

The rule of floating and sinking is

If it is denser than water it

If is less dense it

She moved around the class and then returned to the board and wrote: "If it is the same density it will". She commented this question opened up a whole new area of floating and sinking and drew diagrams on the board showing substances floating at different levels. She then stated:

The next question is Why do hot air balloons float?

She asked for someone to answer, suggested she would pick someone at random and named N. He replied "the gases they use are lighter than air". The teacher asked what gases were used. Students suggested helium and hydrogen. The implications of this were discussed. The teacher stated balloonists use hot air because they are able to control the rate of ascent.

She then asked "What is inside the balloon?". The teacher talked with some students and then moved to the front bench and stated the student needed to remember about the mass of the basket and the burners. She drew particles in the balloon.

A student asked:

S Why doesn't the room fly when we turn on the heater?

T OK, good question.

The students offered suggestions such as the room was too heavy and stuck to the ground.

She posed a series of 'questions for experts' which included "What happens to air as you go up?", "Up high will you need to fire the burner more or less?" and "What difference will hot and cold days make?". She concluded the discussion by saying:

There have been lots of ideas from different people ... some of you have still not spoken ... but I think that you've got it OK. (T7/FN8/96)

This episode is viewed as an example of formative assessment because the teacher provided the students with feedback on the appropriateness of their explanations. She also acted to provide opportunities for the students to test out their ideas. Some students took advantage of these and received individual feedback on their thinking in the whole class situation. By recording some ideas on the board, she provided explicit feedback to all the students on what counted as an acceptable scientific explanation of the concept of density.

The teacher's view of the episode

Teacher 7 said her plan for the lesson had been to ask questions and build on the students' ideas. She described this approach as risky because, as she explained on another occasion:

You try and do one thing and you end up with this quagmire of other stuff that you never even dreamed was there. (T7/D1/96)

She was relieved and pleased at how the lesson "flowed":

I didn't really know how it was going to go. ... I was very pleased that it actually drifted along a nice little path ... actually it went very nicely. There were odd little things that cropped up ... like the house lifting up if you heat the room up. I thought that was lovely. ... It was quite a relief that it went that way and they didn't just ... sit there on the definitions. ... it sort of flowed. ... Sometimes in discussions ... you hit one thing and you really can't go anywhere else, or nobody wants to bother with the whole thing. (T7/D8/96)

However, she noted it was dangerous to assume all the students understood an idea on the basis of a whole class discussion. She had considered the class were "quite happy with the fact that the air was particles from the stuff we'd done previously" until a student had asked her privately "When you heat it [air] up, does it turn into a gas?" (T7/D8/96).

The next episode is another sets out another occasion in which the whole class focused on the concept of density.

The Tower

This episode took place two lessons after the discussion on density. Teacher 7 had set up a measuring cylinder containing six liquids with a solid floating at each interface. She asked the students to explain "What is happening here and why?" for homework. The episode started at the beginning of the next lesson when she asked for answers to the question. The researcher field-noted this episode (the students who were involved are coded S1, S2, S3 and S4):

The teacher told the students she wanted to hear "the views of those students who might not usually answer". She stated she would randomly select some students and she did this by pointing at the roll and naming a student. She asked four students for answers. The first said:

S1 The top is less dense than the bottom ... in the middle it's the same density.

She asked him to explain the middle of the column with the grape and the sea and fresh water. The student queried whether the water was different and if she was trying to "confuse" him. The teacher explained:

T If I ask a question ... I am trying to understand how you think ... To clarify the question ... I expected you to talk about the materials in there ... I am not sure you understand.

S1 The grape is less dense than sea water ... but not as dense as water is. Is that what you wanted?

The teacher confirmed it was.

The second student said:

S2 ... things denser than water sank ... things in the middle floated.

T ... Do you think the bung is sunk?

S2 spoke very quietly and no other comments were heard.

The third student was reluctant to reply but the teacher encouraged her. She said:

S3 I really have no idea. It might be because ... (she described the layers of liquid, then the materials using the words lighter).

The fourth student said he had not done his homework but he said:

S4 (inaudible) is heavier than water ... then there are grades of heavy ... salt water is not as dense as glycerine.

T OK ... good. What about the things?

S4 The material less dense than the substances are floating and those denser than the substances are on the top. Technical.

The teacher asked the students to write down the materials in order of density. She moved around and looked at their books and talked with them. C asked "How dense are we?" so that the class heard. The teacher asked "What makes people float and sink?". The students talked about breathing in and out while floating. The teacher said "we are about the same density as water" and then asked if people would float on mercury. She demanded a show of hands. Only two students indicated they would sink. She asked each student "Why?". They both responded quietly and their replies were not recorded. The teacher did not press them further.

The teacher then asked a student to read out what he had written down as the order. She concluded the episode by stating she considered the students understood the idea of density. (T7/FN10/96)

The researcher considered the students were tense during this lesson, especially while the teacher was selecting someone to answer. They appeared attentive while other students were replying. The researcher interviewed S1 and S3 at the end of the lesson as they were members of her interview groups.

The teacher's view of the episode

Teacher 7 described the episode as formative assessment in which she had focused on "a smaller bit of knowledge". She had been:

Seeking confirmation the students understood what had gone before: ... checking up that they could transfer the ideas ... I expected them to have got it ... I hoped they would use the right language to show they understood about different densities. ..I said here is a situation, explain it. (T7/D10/96).

She had been surprised at the vagueness of the first student's response. She "expected them to be spot on, straight away" (T7/D10/96). Her expectations formed her pre-determined criteria for what counted as an acceptable response but these criteria were implicit until she responded to the first student's answer. The teacher's response made her criteria for a successful answer more explicit in a way that "funnelled" (Bauersfeld, 1988) the student's subsequent answers so he was able to display the knowledge she was seeking. This procedure could be viewed as providing the student with the opportunity to display the knowledge the teacher was interested in or as limiting his opportunity to display what he knew. Teacher 7's funnelling of the student's answers was consistent with her "confirming" or "checking" purpose for this activity and revealed her summative assessment purposes. It was only after discussion with researcher that she appreciated the activity was "a summative activity which included formative assessment" (T7/D10/96). There was no school-based assessment scheduled for student understanding of density and so she had used the activity to do this (T7/D10/96).

The teacher explained she had responded to student answers in different ways based on her prior knowledge of the student and their responses at the time. She questioned the first student further because she considered his response had been an "off the cuff reply ... given with not much thought" (T7/D10/96). In contrast, she had not probed the second student's answer because the student rarely spoke in class even though she questioned whether the student understood floating and sinking except in relation to water. The teacher said she had not "pushed" the two students to explain why they would sink into mercury because "the look on their faces said, "Oh my gosh, don't ask me any more"". Her actions had intermingled science, student and care referenced aspects in that they served to maintain and enhance her relationship with the students and the students' relationships with

each other. She had not pressed for answers that might have revealed the student did not understand the ideas.

Comparing the density lesson and the tower lesson.

The student's responded very differently to the two episodes during class time and when interviewed. The seven interviewed students considered the lesson on density had been a very successful lesson. They reported that at the beginning of the lesson they had been unsure what density was but by the end they were confident they understood:

We didn't really understand it yesterday ... today I understood what we were learning (SG71/L8/96).

They reported it had been helpful to hear a range of explanations (SG71/L10/96)

However, the teacher's explicit validation of some of the explanations by recording them on the board had served to confirm for them that they understood density (SG71/L10/96). This suggested they attributed the teacher with the authority to legitimate ideas and construed the board as a place where authoritative ideas were represented.

During the interviews following the tower episode the students focused on being questioned. They described the episode as "like the end" and "this is the conclusion, sort of thing ... a summary". It appeared the teacher's targeting of students to answer a closed question and her indication that she was seeking a particular answer communicated a summative intent even though the teacher only recognised that her intentions had been both summative and formative after the lesson. In contrast, they described the discussion on density as a time they were negotiating, with the teacher's mediation, an acceptable definition of density:

S76 A discussion is different. Everyone in putting in their ideas.

S73 Because everyone had different ideas.

S76 In a class discussion everyone puts forward their ideas. ... I do in class discussions but not in [summative situations] (SG71/L10/96)

During a member check two months later, the researcher described these two lessons to the students and asked them how they decided whether a teacher was checking on their ideas or discussing them with them. One of the groups differentiated between these two activities on the basis of the questions the teacher asked. Of discussion they said:

S77 In discussion time it is not as much, she is asking you questions. You are giving more answers and she is not asking as many questions. You are giving her thoughts and stuff.

....

Res I have sort of got this but I still don't understand, I'm sorry. In discussion time it is different, she is asking fewer questions?

S's Yeah.

S74 But not of, you have got to use your head.

S75 She is giving more ideas.

Res She is asking fewer questions and they are, are they sort of different?

S76 Longer.

S74 Some are a bit longer than.

S76 Quick questions.

S77 If she says the question then someone ... will answer it. Then someone else will give their view and someone else. (SG72/MC/96)

Of teachers checking on their understanding they said:

Res In checking?

S78 She is giving us a whole lot of original questions.

S77 ... she will ask one particular person.

S74 And she just goes [on] until someone gets it right, really.

S76 She just goes 'You', 'You', 'Yes'.

S77 And if it is right, she just goes onto the next one [question].
(SG72/MC/96)

Although the students considered “checking cuts in with the discussion” (SG72/MC/96) this episode indicates students are sensitive to teacher assessment purposes, particularly when they are summative. The students were reluctant to

reveal their thinking when they considered the teacher was checking on their understanding. The risks were too high. It seems that subtle changes in teacher questioning styles communicate their assessment purpose.

Another aspect of the tower episode is that the two interviewed groups perceived the teacher's actions very differently. Although the teacher had overtly selected students at random one group of (four girls) thought the teacher's selections were random while the other group (three boys) did not. A student from this latter group was the first student named to explain the layers in the measuring cylinder. This group said the teacher had "sometimes picked the person" and considered she had chosen two students because they had not done their homework. This coloured their response to the teacher's intended action as was illustrated by S1's tone, body language and questions during his interaction with the teacher. These indicated he considered the teacher was attempting to "catch him out" rather than to find out about his learning.

Another aspect of student experience of teacher formative assessment highlighted by these two episodes was the importance of the teacher taking time to ensure the students understood ideas. The students considered the first lesson had been successful because the teacher had taken time. They said:

S74 I think she took more time with it.

S75 She is not really a rushed teacher. Like before she finishes it she makes sure that everyone understands.

S76 Everyone is right.

Res. So is taking time important?

S's Yes. (SG71/L11/96)

Their later comments indicated the meaning of taking time derived from their experience in some classes that teachers were constrained to cover the curriculum.

4.7.4 Summary and Discussion

This case study was unique because the topic for the unit was a single concept - density. Over the course of the unit, the teacher's learning purposes and formative

assessment focus evolved from eliciting prior views, to developing shared experiences, to negotiating the meaning of density and using it to explain a new phenomena. Her learning purposes, expectations of what the students would do and say if they held a particular conception and prior experiences influenced what she noticed and her interpretation of student actions as was illustrated in Cameos 14 and 15. She also commented that the importance of prior knowledge and experience was highlighted for her when she observed student-teachers. She considered student-teachers did not always appreciate the significance of student comments and actions and therefore did not respond soon enough (T7/D5,7/96).

The teacher's actions were usually science and care-referenced. She deliberately acted to maintain and enhance her relationships with the students and student relationship with science. She used practical experiences and empirical evidence, suggestions for alternatives, and analogies based on her knowledge of student interests to challenge student ideas. The teacher also provided opportunities for students to test out their ideas. Together, her actions and comments indicated she considered students actively construct their own understandings of activities and ideas.

The students appreciated the respect with which the teacher accorded them and their ideas. They considered she knew them as individuals and was concerned that they understood ideas. The teacher's eliciting their prior knowledge, her not "putting down" their ideas, using language they understood and providing suggestions was said to communicate this. In particular, suggestions were said to "keep them thinking" thereby reinforcing the notion that they were thoughtful and learning school science involved making sense of experiences.

The students were sensitive to teacher assessment purpose, particularly when they considered it might be summative and/or associated with a management function that was likely to involve an attack on their dignity. Subtle variations in the teacher's questioning style were said to communicate different assessment purposes. Student questions served as rich and robust sources of information on student thinking for the teacher.

To summarise, the teacher formatively assessed the students through planned tasks and by interacting with them. The focus of the teacher's formative assessment was the development of students' understanding of density. To accomplish this, her formative assessment purposes evolved throughout the unit to accommodate changes in the activities she was using and the understandings of the students. The students construed formative assessment as embedded in interaction and as serving to legitimate what counted as science. It appeared they experienced it as contributing to and being shaped by relationships and respect thereby suggesting the teacher's concern to act in science and care-referenced ways was justified.

4.7 Summary of the case studies

In this chapter, the formative assessment in seven classrooms was described in terms of the setting, teacher views and formative assessment as identified by the researcher. Teacher formative assessment in each classroom was accomplished through social interactions in and around the use of planned tasks (planned formative assessment) and interaction with students while they were engaged in learning activities (interactive formative assessment). Teacher formative assessment was an activity undertaken for the purposes of enhancing students' personal, social and science development. In the study, the assessment of student personal development related to skills such as self-assessment, time management and research skills. The assessment of student social development related to the students' social skills in listening, discussing and co-operative skills. The teachers' formative assessment of students' science development related to the development of students' practical skills, to their understanding of scientific concepts and to their seeing the relevance of scientific ideas in their lives. The teacher's science focus was on whether students had learned what they intended and/or on what skills and understanding they were actually developing. The teachers deliberately used their formative assessment to inform their immediate and long term teaching actions, to communicate their expectations, to foster student self esteem and support motivation, to ensure students completed tasks, to support student self-assessment and to guide student learning. They were concerned that their assessment should "benefit" and not harm their students but

their exact purposes for formative assessment varied within a lesson and across a unit.

The teachers' formative assessment actions and interactions appeared to be framed by the school setting, their knowledge and understanding of the class, the classroom, the topic of study and the activities they used.

The teachers' formative assessment practices were generally consonant with their views of teaching, learning and assessment. Key aspects of their views seemed to be whether they saw assessment as informing their teaching or as informing student learning more directly and the importance they placed on student motivation. The forms of formative assessment the teachers used were significant because they construed students as learners and school science in different ways so that learning and the formative assessment of it were experienced in different ways in different classrooms.

The student views set out in this chapter indicate that students are active and aware participants in the assessment process, particularly if they considered it might involve their summative assessment. The next chapter sets out in more detail the range of ways students perceived and experienced formative assessment.

5. Student perceptions and experiences of formative assessment

5.1 Introduction

Student perceptions and experiences of formative assessment are the focus of this chapter. The aim is not to portray student reasoning about assessment at an individual level but to set out the ways that students perceived and experienced formative assessment and to understand how their experiences shape and are shaped by this.

Data from three sources were collated to map out student views. The sources were: (i) individual student interviews with 31 students during phase 1 of the study, (ii) end-of-lesson and end-of-unit discussions with 82 students in phase 2 and (iii) the researcher's participant observations during phase 2. The student interview data from phase 1 may be distinguished from the more contextualised end-of-unit and end-of-lesson discussions in phase two through the coding: data from phase 1 is coded (Sxx/I/95a) and data from phase 2 is coded (Sxx/I/95b or 96). For the data from phase 2, not all students spontaneously commented on or were asked to comment on every issue outlined here but in most instances eight to ten students discussed the points made. When most or very few students commented on an issue this is noted.

Student perceptions and experiences are discussed in terms of (i) their perceiving formative assessment as embedded in interaction, (ii) their construing it as an intentional activity in which (iii) disclosure was an important aspect. It is also discussed as a (iv) situated activity which (v) teachers engage in for a variety of purposes and which (vi) contributes to the meanings made in a classroom.

5.2 Student views of formative assessment as embedded in interaction

Student comments and actions indicated they perceived and experienced formative assessment as embedded in interaction. In phase 1 they identified a range of teacher assessment actions (Section 5.2.1). In phase 2, the students reported teacher (Section 5.2.2) and peer actions (Section 5.2.3) as serving a formative function.

5.2.1 Teacher formative assessment as identified by students in phase 1

The first way the students indicated that formative assessment was embedded interaction was that twenty five of the thirty one students interviewed in phase 1 readily identified a range of formal and informal teacher actions as strategies teachers used to find out about their learning. All the students identified at least two strategies. These are summarised in Table 5.1 below (see Cowie & Bell, 1995 for further details).

Table 5.1 Teacher strategies for obtaining assessment information (n = 31)

Teacher strategies	Number of students
questioning and observation	25
tests	16
interaction with the whole class	6
self assessment	7
brainstorms	2
peer assessment	1

The most striking aspect of student responses was their association of teacher-student interaction with assessment. This link was clearly illustrated by the student who explained teacher assessment as:

They peer over your shoulder. ... They would say "Good" or "What does that mean?" 'Cause sometimes you could just write it down and don't know what it means if you don't know they say "Come and tell me when you

know what it means". And if you don't go and tell them they say "So and so, do you know what this means?".... (S53/I/95a)

A similar range of strategies was identified by the six Year 7 and 8 students, who were unable to identify any strategies their teacher used, when they were asked to pretend they were a teacher.

The students in phase 1 described four main means teachers used to provide them with feedback on their learning (as shown in Table 5.2 below). Some students identified more than one form of teacher feedback.

Table 5.2 Means of teacher feedback

Means of teacher feedback	Number of students
Talking to the teacher	12
Comments in their books	10
Test results	4
Reports and parent-teacher evenings	3
No means	8

Representative descriptions of how they found out what the teacher thought of their learning were:

Marks you get in your book, comments you get in your book ... they can tell us, though it hasn't happened to me yet. (S42/I/95a)

When you take your work up to him when you think you're finished, he makes sure its all right. And if something is wrong he just tells us to go and fix it up and then we bring it back up to him. ... After studiesyou write down what you think you have done and then the teacher looks at and he thinks, whatever. (S11/I/95a)

Comments such as "Good work", 'Going OK' and 'Doing well' were said to enhance motivation as one student confided: "Comments like well done, keep it up make some students real happy and they'll try to do it again" (S84/I/95a). However, these comments were not considered as helping them understand why

their work was good. They considered teachers should have to explain this as one student stated very forcefully:

Parliament should make a law that teachers have to say "because". They always make us explain why (S53/I/95a)

In summary, the thirty one students in phase 1 described a range of actions teachers used to gather information and provide them with feedback. Their comments suggested they perceived assessment as embedded in teacher-student interaction.

5.2.2 Student reports of teacher assessment actions in phase 2

A second way the students indicated they experienced teacher formative assessment as embedded in interaction was the identification by all the students interviewed in phase 2 of occasions they had interacted with a teacher as times the teacher had found out about their thinking and/or provided them with feedback. A representative description was:

She came round and she talked to us about what we were doing and then she, I don't know about the others, but she read my aim and hypothesis and my conclusion. And just asked me if I understood what I was doing and watched us doing it. (SG91/L3/96)

The students were emphatic the teacher had not assessed their thinking if he or she had not "come around" and spoken with them. They emphasised the importance of one-to-one interaction. A representative comment was:

Res Do you think the teacher found out anything about your thinking today?

S89 Not really. She never really came around to us. (SG74/L5/96)

The students noted that very often teachers did not interact with every student. To this end, twelve students, all Year 10 queried whether teachers assessed them as individuals. It was suggested teachers only gathered assessment information from

students who sat at the front and/or understood ideas and did not “recognise” people in the “middle” of the class. One student explained:

There is a thing in our classroom of people who don't listen ... but have a personality that teachers really like and so .. the teachers really like those people ... and then there [are] ... the really brainy people and they really love them but they miss the people in the middle. ... and if they do something good no recognition is paid to them. (SG91/L5/96)

Seen this way, teacher formative assessment may be seen to communicate a concern for and interest in a particular student.

It was proposed that teachers care for the class rather than individuals:

They don't really care for the individual person. They sort of care about the class more than one person. they just go "class do this", "could everyone do this, are you happy with it?". ... they don't take any notice of you. (S104/I/95a)

Other students asserted: “They [teachers] don't work with people they work with the group”. Working with groups was seen as making it “easier” for the teacher:

She likes us working in groups, I think. It makes it easier for her. She goes "Right group 1 what do you answer?" ...She likes us to work together to get an answer and give it back to the class. (SG71/L6/96)

In contradiction with the general view, two groups spoke of the teacher’s focus on groups as an advantage because they preferred to work as a group (SG71/L4,L6/96).

After the lessons, the students identified a range of teacher actions as feedback. These included suggestions for alternative ideas and action. One student described her teacher’s actions thus:

She came around and looked at everyone's work and asked if they did understand and perhaps said "Oh well, maybe if you tried it this way or that way it may work better" or "Have you tried doing this" [Yeah] or "Maybe you need a few more different pens". (SG91/L3/96)

They also identified teacher facial expressions (Cameo 4), only writing some answers on the board (Cameo 15) and responding to an answer with a question (Cameo 4) as functioning to legitimate ideas as scientific. Teacher actions and reactions were said to communicate information about teacher priorities and views of students. In particular, teacher time and attention were said to communicate what and who was important to the teacher. Initially, the students stated pragmatically that they concluded what was tested was important to the teacher. Prior to testing, they stated what the teacher spent time on indicated to them what was important. The effect of teacher attention was summarised by the student who said:

If the teacher spends half an hour to an hour talking about one little atom you know it is going to be quite important.(SG92/L4/96)

In another example, six students commented that if their teacher did other work when they were working on a task, they concluded the task and/or their understanding of it was not important to the teacher. One student explained:

S53 It is a bit annoying if she sets you work and then goes off and doesn't really care what you do.

S's (murmurs of agreement)

S53 And then it kind of gives you the impression that it is not that important. (S53/I/95b)

Similarly, the act of assessing and not assessing particular students was perceived as information on who was important (to the teacher). Being prepared to re-explain and revisit ideas was described as an indication a teacher was concerned with understanding rather than curriculum coverage (SG74/L6/96; SG91/L7/96; SG92/MC/96). The influence of these actions seemed to derive from teachers'

institutionalised position and the students' view that teachers only assess and give time and attention to what is important in the classroom.

5.2.3 Interactions with peers as formative assessment

A third way in which students construed formative assessment as embedded in interactions, was their assertion that interactions with peers served a formative function. In phase 2, the students indicated that peers were asked for advice with tasks when they were "stuck" and to confirm their thinking was "right". For example, one group said they had asked "the other table" for help during a lesson. The students described this as a strategy they used "quite often". Three students explain:

S74 We asked the other table.

S75 We do quite often.

S75 It is usually cos she has explained it to them already.

S77 We ask other students quite often just to see if we did it right. We ask them what their answer was and we compare it ... if it is different we think well one of us must have done it wrong so you do it again ... or ask the teacher. (SG71/L6/96)

Twenty students noted that "sciency" or brainy students were an important source of help given there was only one teacher. One student explained:

It's good that there are like sciency people in the class because then she has more time to spend with the people who don't understand what they are doing. Then she can explain. And the people who know what they are doing can also help other people. (SG71/MC/96)

The students indicated help from peers was preferred to that of teachers - teachers were said to be the last people who were asked for help. One student explained:

I ask a friend ... if it was really, really important and none of my friends knew it I would ask the teacher but usually my friends do. (S56/I/95b)

The students commented that peers also provided them with unsolicited feedback. For instance, peers were reported to respond appreciatively to questions that targeted a general concern but to respond to ill judged questions that “held-up” the class by suggesting the questioner was “slow” or “stupid” . (See Section 5.4.1 for further details). When asked, twenty students said peer feedback was as influential as that provided by teachers in terms of its influence on their view of themselves.

In review, the students indicated they experienced formative assessment as being embedded in their interactions with peers and teachers. They described interactions with teachers and peers as equally influential. Thus understood, formative assessment may be viewed as a social activity.

5.3 Student construal of themselves as active and intentional participants in formative assessment interactions

Students construed themselves as active and intentional participants in formative assessment through their descriptions of the criteria they used to self assess, their responses to feedback and their actions in negotiating ideas and questioning. Their comments highlighted that learning was not the students’ only goal in the classroom.

5.3.1 Student reports of formative self assessment

In phase 1, the students construed themselves as active and intentional participants in formative assessment, through their ability to describe how they decided they understood something, although it appeared they did not always use criteria that a teacher might (See Cowie & Bell, 1995, for details). For example, the students said they concluded they understood ideas if they completed a task quickly, they enjoyed doing it, their tests marks were good and/or the teacher confirmed their ideas were correct. Nine of the thirty one students associated understanding with feelings of connection and completeness in a manner that suggested learning involved sense making. The scope of this view was illustrated by a student who said she had developed “an instinct that you feel like you’ve missed something” -

she knew she had learned something when it “made sense” (S103/I/95a). Of these students only three gave rich descriptions of learning. The most comprehensive was from a Year 7 girl who said:

[about learning German in her own time from a CD] ... It's just sort of a feeling and you can tell you have got it ... it feels as though the conversation is a conversation not just pieces It's like a programme I watch: "Piecing the Puzzle" .. it sort of puts it together in their places. Like the jig saw pieces in their places [if she doesn't understand] it is like a 500 piece jigsaw puzzle. You get all these bits you know and you have got them all in the right places and you have got these other pieces which don't really fit in and you can't figure out where they go or anything like that. When I go up to Mum and she explains it again to me, they all fall into place without me doing anything, it just falls into place. (S43/I/95a)

In phase 2, five groups of students described to the researcher how they had assessed their ideas during whole class discussions thereby construing themselves as actively involved in formative self assessment. The criteria they reported using were those of coherence, agreement with an authority and the ability to explain empirical evidence. For example, of listening to a discussion on weight and mass two students said:

S94 You ... check your own [ideas] just to see if whether what you've said is clear enough or whether what they're saying is making more sense than yours. You might be thinking it their way but not being able to put it down on paper in the words that you want.

S95 Or that their way of thinking is better or clearer. (SG91/L8/96)

In another example, a student spoke of listening to a discussion about density. She said:

I didn't really understand at first what we were on about. I had to wait. Like when C. I knew the word that I wanted, like density but when I heard C say it, I thought that's the word that I need so wrote my sentence then but before that ... I didn't really understand what we were doing. ... That put me

on the right track, almost ... Listening to other people put me on the right track. So I understood what was actually happening. (SG71/L10/96)

When asked if they found their peers or their teachers more persuasive, they said:

S94 [We take]more notice of the teacher cos they have had more education than we have.

S95 They have been learning longer.

S94 Oh, I don't know.

S95 But sometimes what the students are saying.

S94 If their idea is reasonable.

S95 Sometimes our arguments.

S94 Sometimes what we are saying makes more sense to us.

S's Yeah. (SG92/L8/96)

That is, they said they could be influenced by a teacher's views (those of an authority) but claimed they prioritised the coherence of ideas. Empirical evidence was also said to be considered. One of the students elaborated on this, saying she asked herself:

Can I make sense of what they [teacher or student] are saying or does so and so's idea make more sense? And can I understand the idea when she puts it that way or when the teacher put it another way. ... More evidence that such-and-such was right or that experiment, this happened because of this. (SG91/L4/96)

Students in the ten classes were observed to seek confirmation that their ideas were correct from the teacher. They also asked peers they described as "brainy". As one student explained:

Today I sat by a brainy person so I asked her. (SG91/L3/96)

They were observed to annotate their answers when the teacher reviewed homework questions (T10/FN4,5/95b), to read each other's written work, to discuss ideas (T5/FN2-10/95b) and to test out their ideas against empirical

evidence (Cameo 13). This suggested they assessed their ideas for coherence and consistency with empirical evidence and the views of those they construed as authorities within the classroom.

The students' negotiation of what counted as an acceptable idea with the teacher also indicated they were assessing their ideas. An instance of negotiation occurred when a class was asked to predict what would happen when potassium permanganate was added to the heated water (Cameo 1). Another instance occurred when a student asked Teacher 7 what answer she had expected (Cameo 15).

5.3.2 Student reports of questioning and formative assessment

Another way the students construed themselves as active and intentional participants in formative assessment was through the importance they attached to being able to ask questions. Their comments construed asking a question as the outcome of a formative self-assessment. This was illustrated by the student who said:

S97 You've got to ask the teacher though, because the bits on ions and how you make [compounds], I really didn't understand that. I couldn't understand that. I asked the teacher over and over again with the whole group. And I ended up just forgetting about it for a while and when the teacher wasn't busy I asked her to come and I finally got what it was.

S99 You were asking us for a while, weren't you. We weren't very helpful because. It's hard, sometimes, you don't know how to put it into words. (SG92/MC/96)

However, the students' description of their involvement in questioning suggested learning was only one of their classroom goals. They claimed that in addition to asking for help to understand ideas, they asked for help to complete tasks, to manage their work load and to maintain and enhance their relationships with others. Their comments construed these goals as overlapping and intertwined with those of learning. For instance, some students said they asked questions to

help them complete tasks (SG83/L6,9/96; SG85/L7/96; S54/I/95b). They saw this as the purpose of classroom activities but sought to complete tasks to keep the teacher “happy” so they were not “picked” on rather than as an activity that might enhance their understanding (SG83/L5/96). That is, they sought to complete tasks in order to maintain a positive relationship with the teacher.

Nine students from three different classes said another reason they asked questions was to distract teachers from the unit topic. The students said they cooperated by “get[ting] the word around to ask him stupid questions so that he doesn’t do something.” (SG85/L5/96). Two students described this deliberate action thus:

People know what is happening. If the work is really easy people think "I know how to do this, I'll just put up my hand and ask something that is really extended and intelligent and see". (SG92/L8/96)

In this case, the students indicated they used their understanding of classrooms to their own manage their work load without alienating the teacher.

Yet another way three students said they used questions was to enhance a teacher’s impression of them. They claimed students asked what the teachers called “what if “ questions because they knew teachers valued this type of question (SG91/MC/96). However, they noted there was a delicate balance between impressing the teacher and being labelled by their peers as “try hards”.

The students’ assertion that they ask questions for reasons other than learning suggests questions do not always provide robust information on their current interests and understandings. This is of concern given the value the teachers placed on teacher questions (Bell & Cowie, 1997).

5.3.3 Student goals and preferred forms of feedback

Student reasons for asking questions indicated they were active and intentional participants in formative assessment and also provided an insight into the nature of their preferred formative feedback. A distinction was identified between

students with learning goals and those with task completion goals (see section 5.3.3). The students who said they asked questions to help them understand ideas stated they preferred feedback in the form of suggestions because, as one student explained, “suggestions are still making us think” (SG72/MC/96). Suggestions were able to be “added” into their own ideas to “give a different way”. They were considered to allow students to “decide for ourselves how” (SG71/MC/96). These students claimed statements such as “That’s not right” and “Do it this way” made them “feel stink” and “useless” at science. One student explained:

Because when they say “You’re wrong”, or “That’s not right” or “Don’t do that” or “Do it this way”, sort of, it makes you think, “Oh, OK, I’m stink. I’m just useless at it sort of thing.” ... if you get them to say like “How do you think you could help this?” ... You think you can do it. (SG32/L11/96)

This form of feedback was viewed “rude” and as a “put down” by the Year 10 students (13 girls and 3 boys) and therefore to imply a lack of respect. The students were emphatic they appreciated teachers “who respected the way you want to learn” (SG32/L11/96) and who “let you learn yourself”(SG32/L17/96). They stated mutual respect was essential if students were to act on teacher feedback (Cameo 13). One student explained:

S32 X is like our favourite teacher. She respects us and we respect her. (SG32/L3/96).

Thus, for these students it seemed that feedback they could use as a thinking device (Section 2.3.3) supported their active involvement *and* it was more likely to be considered.

In contrast, students who were interested in task completion said they appreciated teachers who helped them to set up equipment and complete tasks. They did not like teachers to probe for understanding. One said:

I hate it when you ask how to do something and they ask us questions back. They [teachers] should just tell us what to do so we can get on. (S84/L5/96).

Another difference between the students who focused on understanding and those who focused on task completion was their view of who was responsible for formative assessment. Three students raised the issue of responsibility with the researcher after a lesson on atomic structure (T9/FN9/96). They had not understood this but they had not told the teacher: "We don't understand this" or asked "What does this mean?". They considered this was necessary because "teachers can't read students' minds" (SG92/L5/96) but said it was not usual for students to do so. One of them explained:

That has happened in other classes. The teacher has been going on and on about something and it was K who turned around and said to the class, "Excuse me, but does anyone understand this?" Everybody said "No". This was .. near the end of the lesson. (SG92/L9/96)

The students who said they asked questions to help them understand ideas described assessment as a shared responsibility. A representative description was:

It is students' responsibility to let teachers know if they don't understand and teachers' responsibility to help students" (S53/I/95b).

In contrast, the students who spoke of learning as task completion asserted it was a teacher's responsibility to find out what they knew or understood. Their view was illustrated by two Year 10 girls. They said they "couldn't really tell the teacher if you don't understand". They claimed it was not their responsibility to do so:

S820 I don't think it should be our responsibility [to tell teachers we don't understand].

S821 No, cause like, we've got our work to do, and like, we.

S820 That should be theirs, they're the teachers.

S821 Yeah, and like, when they expect us to get our work up to date and if they want our books answered and everything, we sort of like, don't really have the time to sort of like, go up to them and say, "I don't understand this". (SG89/L14/96)

Students from other classes also claimed it was a teacher's responsibility to take in and mark their books, to follow up comments and to make sure they understood ideas (SG91/L5/96; SG72/L8/96; S53/I/95b; SG22/L2/96).

Student perceptions of who is responsible for assessment are important because, as some of them noted, the teacher is unlikely to be able to assess each student every lesson (SG71/L9/96; SG92/L5,7/96). Moreover, the students' comments indicated that if they focused on completing tasks they were unlikely to seek help to understand ideas and may not even consider it is their responsibility to let the teacher know they couldn't complete the task.

5.3.4 Student goals and teacher feedback

Student comments and actions that indicated they only responded to teacher feedback if they shared his or her goals suggested they were active and intentional participants in formative assessment interactions. In phase 1, all thirty one students said they only used the information in teacher feedback (suggestions, comments on their books and test results) "sometimes". Whether they used the information was said to depend on how important the learning was. One student summarised their view thus:

Depends, if it is, like, really important information. If it is something you can live without or not. I mean if you can live without, why bother learning it? If it is life threatening, yes I will keep it in my head..... If I get a really bad report, well, I upgrade myself a bit. (S83/I/95a)

In phase 2, the need for students to share the teacher's learning purpose was illustrated by an activity that required the students to determine whether a masked can contained diet or normal coke. The students were provided with a can of diet coke, a can of normal coke and a masked can to do this. The ten teachers anticipated the students would use scientific problem solving skills and the notion of density but found the students used visual clues and their prior knowledge of which drink had the most fizz. Two students explained their actions thus:

S74 We just wanted to see how long it fizzed and all that.

Cause we knew that um, the Diet Coke was less fizzier.

S75 Cause it still got a different taste, but it's still less fizz. (SG72/L12/96)

The students pursued these strategies in the face of teacher encouragement to think more deeply. They were only concerned to identify the masked can so they could drink the contents.

In summary, students' descriptions of how they assessed their ideas, of classroom questioning and their use of feedback indicated they were active and intentional participants in formative assessment. However, it appeared learning was only one of their goals; they also sought to complete tasks, reduce their work load and maintain and enhance their relationships with others. An important aspect of student goals was whether they pursued learning or performance goals and whether their purposes for task engagement were aligned with the teacher's. This was related to how they viewed teacher-student responsibilities for formative assessment and how they responded to teacher feedback.

5.4 Disclosure and student involvement in formative assessment

Disclosure was the third aspect of formative assessment highlighted by student comments and actions. Disclosure relates to the extent to which a task or activity produces evidence of student performance or thinking (Section 2.2.3). In the classrooms, the teachers used tasks and strategies to elicit student ideas and students voluntarily disclosed their ideas by asking questions and discussing their ideas. This section reports on student perceptions of (i) the disclosure of teacher assessment strategies, (ii) the relationship between teachers' rights and disclosure, (iii) disclosure as a source of potential harm, (iv) student views of learning as an influence on disclosure, (v) disclosure as a dilemma, and (vi) trust as mediating disclosure.

5.4.1 Disclosure and teacher assessment tasks and strategies

In both phases of the study, students criticised tests, whole class discussions, self assessment and teachers looking at their books as restricting and/or causing them to limit the disclosure of their thinking for a range of cognitive, affective, social and relational reasons. They indicated one-to-one or small group interaction minimised the negative effects of many of these factors.

The scope of student perceptions of the limitations of teacher assessment activities was reflected in their criticisms of tests. For example, one student in phase 2 claimed a recent test had not generated information on her knowledge because the bulk of the questions were on an aspect of the topic she did not understand. This student was incredulous and concerned her teacher seemed unaware that the information the test generated was unrepresentative.

A lot of tests, teachers don't find out what they really want to know, but don't, they don't seem to notice it. (S42/I/95b)

The students also claimed that tests produced limited information about their understanding because of various communication difficulties. For example, they could not answer some test questions because they did not understand them. One student explained:

Yes, like in the science test it said name, um, I can't remember it was name, the make processes soil, and I thought it meant describe it. But it was actually just one word.(S54/I/95b)

Another dimension to language difficulties was mentioned by ten students who said, "you couldn't always put the answer in words".

The affective effects of tests were also given as a reason for their limited disclosure. Twenty nine of the thirty one students in phase one said tests invoked feelings of nervousness. Their typical reaction was: "[Sigh] I hate tests." (S72/I/95a). They stated that nervousness often caused them to become "blank". A representative comment was:

Some people get nervous in tests and so they forget all their work.... cause sometimes I might not understand all of it and I might get nervous and the you just get a really bad mark and really you do understand it (S104/I/95a)

The social organisation of tests was identified as a factor that limited disclosure. Twelve students in phase 1 reported, that in contrast to their lessons where they were encouraged to discuss ideas, they felt inhibited by the social isolation of silence during tests. Their view was illustrated by the student who said:

I don't really think heaps of tests shows it [your learning] you get really nervous and you are not round your friends. If you are round your friends you can discuss things or decide things together. But if you are doing a test you can't. You don't show half as much as you know put down in a test. (S51/I/95a)

It was also suggested that various cognitive, affective and social-relational factors limited the disclosure provided by whole class discussions, teacher observation, self assessment and student books. In whole class discussions, for instance, the social factors of audience and anticipated audience response were identified by many of the phase 2 students as the reason they were reluctant to ask or answer questions. An inappropriate question could, they considered, result in teacher and peer responses that made them feel “embarrassed” and lead their peers and teachers to consider them “stupid” or “slow to understand”. Two students explained the class response:

S95 If the majority of the class do know what they are doing and you don't then it is really hard because it is like "Ohhhh (sighs), I have to explain it **again**".

S94 You feel a lot dumber

S96 And all the other students look at you and you are going (shrinking down in her seat) (SG92/L7/96)

The social organisation of self assessment was identified as impacting on disclosure. In phase 1, two students queried whether self-assessment was a

genuine activity because they were being asked to record for the teacher what they already knew:

Well I find them a bit boring because I know that the teacher wants to find out ... about what you've done and how you rate yourself, but it's really just ... telling yourself what you already know. (S51/I/95a)

Six students said the teacher reaction they anticipated influenced what they recorded. One student explained:

For self-evaluations I have this little system, and when it says put your mark and it says put your teacher's mark, you put what you think is a little bit lower than you think is fair and then when the teacher comes along and you see that she's put ... if you put like, B- and she put A or A- or something like that, you say, oh yay she thought I was worth an A. But if you put something really high and she put something really low, you go away thinking ... hmmm. (S53/I/95a)

This quote suggested that the student tried to out-guess the teacher. This was confirmed by her suggestion to a fellow student that when self assessing, teachers liked students to state what they had done well and then add 'but' and describe what they could improve (S54/I/95b). Self assessment was observed and discussed with the students of Teacher 2. They indicated that the need to disclose their assessment to peers and the teacher undermined the fidelity of the recorded information. It seemed that when students were asked to record and disclose their self-assessment to the teacher, self-assessment, like tests, became a strategy teachers used to elicit information for their own purposes.

The need to maintain their relationship with the teacher was the reason fourteen students in phase 2 gave for the limited validity of teacher observation. They claimed students "worked" and/ or pretended to be able to do an activity when a teacher was observing them during written work. One student explained:

Some kids just sit there and they struggle with these questions and the teacher just thinks we're doing OK, cause they act like it. I know heaps of kids ... they pretend (S53/I/95b)

They also claimed they "pretended" to be listening and understanding during whole class activities. One student explained her actions thus:

And the teacher can't tell [if we understand] because some of us just sit like this [sitting up and paying attention]... even if we do understand it. ... Sometimes they can't tell just by looking at us ... if we understand it (SG71/L9/96)

Student book work was said to provide little information on individual thinking because of the social organisation of tasks. Six students from the class of Teacher 5 commented that as they worked together their written class work reflected the group view. Altogether, fourteen students in phase 1 questioned why teachers did not assess group understanding given they encouraged group work. This issue is important when learning is viewed as a social process.

In contrast to other strategies, the students in phase 2 asserted talking with a teacher individually or from within a small group minimised the negative affective, social and cognitive factors they experienced with other assessment strategies. They considered individual interaction was central to effective teacher formative assessment. One student explained:

Sometimes she has got to come and talk to you individually because ... if they just say "Does everyone understand?", you are going to feel like an idiot saying "No, I don't". (SG71/L7/96)

They claimed that when they talked with a teacher they could clarify what she or he wanted to know. Their comments suggested the social consequences of not understanding were minimised when the audience was small - typically the teacher and a group of friends. For example, one student said:

If someone hadn't understood it, when they were actually doing it [an experiment or other small group task] they'd speak up but when we are just sitting there listening [in the whole class discussion situation] ...you don't really. You can't tell. (SG92/L10/96)

The students considered teachers provided them with more useful feedback during one-to-one interaction because *they* were more explicit about what they did not understand. One group explained that when the teacher “comes around” they were prepared to ask her “to re-explain it, just to you personally or to the group”. Three or four students (a sixth of the class) were observed to approach their teachers as soon as small group work commenced thus supporting their claims they valued interaction with teachers.

In review, the students' indicated they were aware of the phenomenon of disclosure. Their comments construed them as analytical of the disclosure provided by the tasks and strategies teachers use to gather information on their thinking. Their comments highlighted the cognitive, affective, social and relational effects that assessment tasks and strategies have on students even before the teacher acts to provide feedback. Student perceptions of these are important given that students need to disclose their ideas before others can move through the assessment cycle.

5.4.2 The relationship between teacher rights and disclosure

Student comments and actions indicated that teacher rights were a significant contributor to disclosure and hence formative assessment in the classrooms. The students, while they criticised the disclosure provided by teacher assessment tasks and strategies, acceded to teacher requests to participate in them. During the study, for example, only three students indicated they were unwilling to share their thoughts during classroom discussions and they acceded to a repeated request question (Cameo 7, 15) thereby highlighting their acceptance of teacher rights to require them to disclose their ideas.

The pervasive and taken-for-granted nature of teachers' right to require students to disclose their ideas was illustrated by their looking at student books. Student

books belonged to the students but the teachers looked at them as a matter of course in all ten classrooms. The students described this action as problematic. They were concerned the teacher might see and judge their work when it was “half finished”. One student explained her feelings thus:

Well, it's kind of nerve wracking. Cause she's looking at your shoulder, and you're going 'Oh, no, she's reading this. Oh no, it's wrong. It's wrong, I'm way off. Oh, no, oh no.' And when she goes away you can go 'Yes'. ... It's like she's looking at your work when it's just half finished. ... She's not seeing it when it's finished. (S53/I/95b)

The student noted this right differentiated between teachers and student - she was not able to see her teacher's work half finished.

The effects of teachers looking at student books was made more problematic by the teachers' tendency to do so while standing behind the student. The students particularly disliked this because they were aware other students were able to see the teacher's reactions to their work and they were not. They described the practice as 'scary' (SG71/L12/96) and, in the words of one student, as making them feel “little like a fly on the end of a pin” (S91/MC/96). It was described as “rude” by the ten students who pointed out it was usually an unacceptable practice. In the words of one boy:

That's rude. My dad, he doesn't like it when he is reading the newspaper. (SG81/L5/96)

This student illustrated the impact of this over-the-shoulder action by standing over the researcher, who subsequently felt intimidated.

Although the students did not like teachers looking at their books, the fifteen students who were asked said the researcher's suggestion that teachers ask to see their books was “silly”. They considered teachers were entitled to see their work. One student said her teacher would demand to see her book if she tried to withhold it:

You can't really say, "No, you're not allowed to look at my work".
She'll [the teacher] just say, "Yes I am." (SS53/I/95b)

Only five students resisted this teacher action - they lifted their desk lids and covered their books with their arm (Case study 2).

For some students, their own inability to manage the disclosure of their ideas was highlighted by their teachers' ability to choose not to "bother" to put in sufficient time and effort to find out about their ideas. Ten students viewed this with concern because they considered they benefited from teachers knowing about their learning. Two students asserted:

S94 Teachers could [find out if students understand] but they don't bother.

S96 I think they're got to look at their priorities. (SG92/L10/96)

Moreover, they claimed teacher decisions about whether to 'bother' were influenced by the teacher's perception of a student's attitude. In a way that suggested this view was long held, one student quoted her sister's advice to her:

That's what my sister said to me. "Don't get into the teachers' bad books if they think that you don't want to learn they won't bother with you. (SG92/L5/96)

These students considered teachers had opportunities to help them but they were able to choose not to.

To summarise, teachers' rights to require students to disclose their ideas was accepted by students and this facilitated teachers' ability to access their ideas.

5.4.3 Disclosure as a source of potential harm

Student comments indicated they often sought to limit the disclosure of their ideas because of concerns about potential harm. Teacher and peer actions were viewed as unpredictable - they could act in ways that undermined student self-esteem and relationships with others or to help students understand ideas. Expectations of

potential harm arising from teacher actions appeared to be of long standing as the students drew on the experiences of their parents and siblings to make their point. For example, one student described how her mother's teacher used to embarrass her mother by asking her, in front to the class, to confirm she understood an idea (S54/I/95b).

The students' perception that interaction with teachers involved risks was highlighted when Teacher 5 was explaining the comments she had written to the class. She told the students she had asked some of them to, "See me" (T5/FN3/95b). The class told the teacher they "hated" this sort of comment because they automatically assumed they had "done something wrong" and would "be in trouble" or be "yelled at" (T5/FN3/95b). One student burst out: "Teachers are like sharks". The teacher asked the students if they could recall her or any other teacher within the past two years shouting at them. Only two said they could but they all assured her, "You never know what will happen." (T5/FN3/95b). The teacher commented to the researcher that it was a student myth that teachers shouted at students, albeit a powerful one.

Other students asserted that one of the difficulties with interaction was that teachers did not always respond to the content of their questions or to them as if they were seeking help to understand ideas. They claimed teachers showed displeasure at being asked, implied they were asking because they had not been listening and / or they were slow to understand. They reported teachers reacted to questions by growling, yelling, shouting, by being grumpy or becoming angry. They described these reactions embarrassing and "belittling". One student explained her view clearly:

The worst thing is when you ask a question and they [the teacher] belittles you in front of everyone and goes "Weren't you listening?" or "Don't you understand that by now?" (SG91/L9/96)

Another student explained:

Sometimes you ask them and they spend so much time growling at you that they never actually explain so you are still left wondering "What are we doing?". (SG91/L5/96)

Two others said:

S74 Teachers sometimes look at you as though you are stupid.

S73 You deaf or something? (SG71/L8/96)

The students indicated the possibility teachers would "bite your head off" made them, in the words of one student, "scared to ask them again" (SG83/L7/96). That is, it made them limit the disclosure of their ideas. Two students said that, given the chance, one change they would make to teachers would be to make them "easy to approach ... not get mad ... if you don't understand it then not shout at you ... not get frustrated and annoyed you have to ask them again" (S56&57/I/95b).

In discussing teacher reactions that attributed students with not listening or being slow to understand, no students mentioned that students asked questions for a variety of reasons (Section 5.3.2). The similarity between teacher attributed reasons and student reasons only became obvious to the researcher on later analysis and so it is not known whether the students were aware of the contradictions in their position.

Another aspect of teachers' rights in the classroom was their ability to disclose student ideas to others without their consent. This happened when teachers replied to a private question in a public way. The significance of this action was pointed out by a student to the researcher after she had approached a teacher for help and the teacher had replied to the class (Cameo 12). The twenty eight students who were asked described this action as potentially harmful because of the possible responses of their peers. They asserted the *possibility* of this action caused them to restrict the disclosure of their ideas to teachers. In a manner that suggested this strategy had no benefits, some students claimed they felt "shame" even when the teacher's comments to the class were "good".

The teacher action of replying to individual questions to the class highlighted the differences in teacher and student perspectives and experiences. The teachers considered this action to be an efficient strategy for providing timely and effective feedback to all students, including those who may not be prepared to ask for help (Cowie & Bell, 1995a). In contrast, the students saw it as a breach of confidentiality leading to potential harm to their self esteem and relationships. They recommended that all feedback on their learning be kept confidential. A representative comment was

Well, if they've got a complaint, they should talk to you quietly. Cause I hate it when they talk out loud and everybody laughs ...then I get smart comments later. (SG81/L6/96)

The students indicated the possibility of teachers disclosing their ideas to others influenced their willingness to ask questions. Twelve students, when asked by the researcher for recommendations to enhance teacher assessment practices, urged that teachers be told about the effects this had on them and their willingness to discuss their interests and ideas.

5.4.4 Disclosure and student views of learning

A related influence on disclosure was the students' perception that quick understanding was valued. This inhibited them from asking questions because of the possibly they would be judged as "slow" and so restricted their teachers' and their peers' knowledge of what they did and did not understand.

Thirty students (all those interviewed from three classes in phase 2) considered teachers expected them to understand ideas and to complete tasks within a specific time. They were aware that teachers' valuing of quick understanding may derive from teachers' obligation to teach what was in the curriculum but they claimed not understanding within the prescribed time produced negative feedback from teachers. One student explained:

It's kind of, they [teachers] set the work and ... if you can do it at the right pace they're doing it, you're OK, but if you can't, you kind of head back and then you get in trouble. (S54/I/95b)

It seemed teacher actions that valued questions that extended ideas also led the students to conclude quick understanding was valued and questions that sought further clarification were not. One student described teacher actions thus:

... if you ask like an extended question, like thinking ahead to try and add something more difficult into an experiment. The teachers say "Oh yes, that's a good question". If you ask something that you didn't understand from before, then that is not a good question. (S92/L6/96)

The students were concerned therefore that their questions would disclose they were the "last one" to understand and lead to their being judged as "slow".

Interestingly, teachers taking time to ensure students understood ideas was a characteristic of three occasions that students reported as being particularly helpful (Case study Teacher 7,9). When asked, what feedback teachers should provide, twenty students of the thirty asked, recommended teachers provide feedback to support effort and persistence. Such feedback has the possibility of countering the myth that learning / understanding should happen quickly and easily.

5.4.5 Disclosure as a dilemma driven activity

Student comments construed disclosure as a dilemma driven action because, in contradiction with the fears about disclosure evident in the previous quotes, all the students reported teachers and peers could act in ways that helped them understand ideas. They considered it part of a teacher's role to answer their questions and expressed the desire for more opportunities to ask questions. For instance, one student said it would be like being away if a teacher did not assess their ideas and twenty recommended the main way teachers could enhance their learning was to provide more opportunities for them to discuss ideas.

The dilemma driven nature of the decisions involved in asking a question, thereby disclosing her thinking, was explained clearly by a student after a lesson on mass and weight. She said:

That is what it was like today. I kept on thinking that I would put up my hand [and ask a question] but then someone else would put up their hand and they would understand it perfectly and I thought "Well, everyone else probably understands it and I don't". ... then I'd look stupid if I put up my hand and asked her to repeat it. She could have already gone over it ten times since I didn't understand it. I'd look like a X for making her explain it once again because everyone understood it. (SG92/L9/96)

In this instance, as the student's friend pointed out, the students asking the questions did not understand the idea. However, at the time, the student had not appreciated this and she had prioritised her academic status and relationships with others over her desire to understand the idea of mass.

5.4.6 Disclosure as mediated by trust

Trust was described by the students as a key interpersonal factor that mediated disclosure. They preferred to seek help from trusted peers and teachers.

The trustworthiness of peers was considered crucial. A representative comment was:

You need to be able to trust others, to be sure their reactions won't be to make fun, talk about or think I am stupid. (S56/I/95b)

Considerate students were said to minimise the threat of asking for help in the social setting of the classroom because they could be trusted to be well intentioned. This was illustrated by a student who contrasted the research class with an option class. She explained:

We know them pretty well but in some option classes you feel like you can't really ask questions because there are other kids who think they are real

neat. They do put you down. They look at you and go, "Why did you ask that?". You sort of feel uncertain. (SG71/L9/96)

A number of girls elaborated on the extra support they gained from working with friends. One group of four Year 10 girls claimed (and the researcher observed) that they did not question the teacher as individuals. Instead they discussed their problems as a group and one of them asked the teacher for help when an issue was unresolved. This is illustrated by the girl who told the researcher:

We don't normally like putting up our hand and saying "I got this answer", we normally say "Our group". ... Because we do all our work, basically, together. ... if we put up our hands and say, "We got this answer" and she realises it is wrong she will come down and talk to us as a group, not individually. (SG71/L9/96)

However, students asking their peers does reduce teachers' access to student thinking.

The trustworthiness of a teacher's reactions was described as influencing student willingness to interact with teachers in ways that disclosed their thinking. The students explained they formed impressions of teachers' likely actions and reactions "over a period of time and from what you hear from people". Three students, interviewed at the beginning of the school year, reported they actively assessed how their new teacher interacted with students (Section 4.6.1)

The students asserted they needed to feel "safe" or "comfortable" with a teacher before they asked questions. One student explained how uncertainty about how a teacher might react led her to ask her parents. She said:

If you've been with a teacher for a while, you sort of, you know their reactions and stuff, if you feel comfortable asking them. But, like, if you're not really sure, like, this teacher I had in primary school ... he was sort of in and out and, you didn't really know if you were going to ask him at the wrong time or not ... so I sort of left it till home. (S55/I/95b).

It seemed the expectations students developed of their particular teacher reduced the unpredictability of teacher-student interactions and if the teacher was perceived as trustworthy this could enhance student willingness to seek help, thereby disclosing their ideas.

5.5 Student construal of formative assessment as a situated activity

The fourth aspect of student perceptions and experience of formative assessment was their construal of it as a situated activity. The data already presented supports a view of student experiences of formative assessment as being shaped by interpersonal relationships and the semi-public nature of the classroom. Student (and teacher) perceptions of teacher rights may also be seen to be related to the classroom setting. Similarly, disclosure was an issue because teachers were expected to evaluate student ideas and had the opportunity to disclose their evaluations to others in a setting in which relationships continued over time and were shaped by such assessments. However, the students also indicated that engagement in formative assessment was shaped by (i) teacher roles and (ii) the nature of school science.

5.5.1 Student perceptions of teacher roles as shaping formative assessment

In phase 2, student comments and actions indicated their engagement in formative assessment was shaped by their perception of teacher and student roles. They expected teachers to judge their ideas, but because they were deserving of respect, teacher actions could not be questioned. Formative assessment was not seen as a reciprocal process by the students.

The students indicated they expected teachers to arbitrate on what counted as right and what might be taken-for-science. One Year 8 student acknowledged she had been socialised to believe teachers are always right and so were able to do this. She said she would not question (argue with) her teacher because the teacher was a “higher authority than you and so you think that what she says goes because it’s right.” (S54/I/95b). Cameos 4 and 15 illustrated the value the students placed on the teacher confirmation of what was the right answer.

The value students placed on having their ideas confirmed as right was an important contributor to teachers' access to information on their ideas. Students in every class sought confirmation their ideas were 'OK', 'All right' or 'correct' by showing the teacher their work or explaining ideas to them. As already noted, student expectations teachers might judge their ideas as wrong led them to limit the disclosure of their thinking.

The role of the teacher in the classroom was also reported to influence student participation in formative assessment because of a student perception that teacher judgements must be respected. In the absence of known (to them) academic criteria, some students attributed their teachers with the use of "personal" criteria to judge their work. In an example that suggested perceptions of teacher subjectivity are widely and long held, one student indicated the reason her mother had received a poor mark at university was that the lecturer was a hard marker. She explained her mother had reached this conclusion because the lecturer "didn't write why he'd marked it [the way he did]" (S58/I/96). Some students also asserted that a teacher's liking for them influenced the marks they received. This view was illustrated by a student who said:

It can also depend if the teacher likes you or not, how good your marks are. I feel that it shouldn't really be like that because in some aspects the teacher has just got to look at your work and things like that. (SG91/L5/96)

Despite the students' concerns about how their teachers judged their work they were not prepared to question the criteria the teacher used. They considered teachers would view their querying a mark as their being "cheeky", "challenging" and "disrespectful". A student explained :

It's probably because, like we've been told, to respect him and it's like, it's like we're answering back. (S42/I/95b)

During the time of the study, only one student questioned his teacher's implicit assessment of his response. He asked if his answer was what she was looking for (Cameo 15). The students' unwillingness to question teacher assessment has

implications for the fidelity of the teacher's assessment as it means teachers do not get feedback on the quality of their judgements. Moreover, student perceptions that teachers do not use academic criteria to interpret assessment information has implications for student self-assessment and student response to teacher feedback. Students are unlikely to respond by reconsidering their own ideas or work if they consider a teacher's assessment is subjective.

5.5.2 Student perceptions of school science as shaping formative assessment

Another situational factor that students considered shaped their engagement in formative assessment was their perception of the nature of school science. In phase 2, student comments indicated they considered there were a number of levels of explanations for scientific concepts, that learning science involved learning 'big' words and that school science was a body of facts. These perceptions influenced their willingness to disclose their ideas and the feedback they considered helpful.

Student perceptions that there were different levels of explanation for phenomena and so students could have different levels of understanding was an important influence on formative assessment. One student specifically raised the point that different levels of scientific explanation were revealed as students moved through school (S51/I/95b). This student considered she wouldn't have been able to understand what she did at the time of the interview when she was younger:

Well if someone has told me that coal is made out of dead tree matter compressed for hundreds of years when I was little, I would have gone 'Oh'.
(S51/I/95b)

Teacher understanding of students' level of work was described as one benefit deriving from teacher formative assessment. One student explained:

Well if they know what you know, and what you understand then they can put it as, like make it to your level of understanding They can target your problem areas. (S104/I/95a)

Another aspect of school science was that it was considered to have a specialised vocabulary and diagrams. The significance of language was brought to the researcher's attention when she member checked her analysis (Section 3.4.6) with a group of three students (S92/MC/96). The students asserted that the language of science could be a barrier to understanding. A representative description of the negative effect of "big" words was:

S99 Today, just really today, she spoke in really big words. I couldn't understand her. She was always talking about protons and neutrons.

S97 That was because that was the only way she could explain it.
(SG92/L7/96)

Symbols and diagrams were also described as a barrier to understanding:

S36 Sometimes he does lamps with two swirls or three swirls and sometimes.

S37 Yeah, I don't even know what those swirls are. I mean some of the swirls, I know that they've been lamps, but you know, there would be lines poking out at different angles and you know, it's really complicated. ... We don't understand, we don't understand, what do these symbols mean? (SG32/L11/96)

Teachers who used big words were claimed to be more difficult to ask for help thereby suggesting students would be less likely to disclose their uncertainties by asking questions. Two students explained this:

S55 Sometimes ... if you get a really nice teacher who understands and if they knew they've said a big long explanation that might not make sense to you. It would be quite easy [to ask] but if you get a teacher who goes on and uses big words ... it gets a bit harder to ask.

S56 To feel comfortable with asking. (S55,56/I/95b)

The students appreciated teachers who used language they understood. As one student said, "Teachers that you get along with, things like that, they put it into the words that you can understand so it makes it a lot easier". The language teachers

used was considered to influence the usefulness of teacher feedback. One student explained:

She's [the teacher] saying these big words and like, like she was talking to B. And she said all these big words to him and then I asked her and she started saying all these big words to me. And I said put it in simpler words; everyone's different. (S85/L7/96)

Teachers coming to appreciate the language students understood was viewed as a benefit of teacher formative assessment. One group explained:

S76 She knows our level of work. Like the four of us are pretty much at the same level in science.

S77 Compared to the others. Like we are not.

S76 She knows she can't talk to us with all those sciencey words. She just uses everyday words.. (SG71/L6/96)

The impact of teachers and students not sharing a language was highlighted in Cameo 6 where the teacher and student were unable to appropriate each other's questions and answers.

One of the reasons the students gave for finding their peers' explanations and feedback more helpful was that they used simpler language. As one student put it, peers can explain without becoming "all technical and stuff" (SG85/L7/96).

The way the students discussed the place of language in the classroom indicated people who were able to use scientific language were construed as knowledgeable. Language, rather than test results, was used to judge whether or not other students were bright as was illustrated by the student who said of his peers: 'They are not that brainy, they just sound so' (SG81/L5/96). Another student described the group in front of her as understanding ideas because they used scientific terms. She contrasted how the teacher spoke to this group with how the teacher spoke to her group in "everyday words":

... the table in front of us, they are all ... quite scientific, they all know words so she can go and talk to them "The solution of blah, blah, given blah, blah, blah" but when she comes to us she has to say all the everyday words. (SG71/L3/96)

The teachers' mastery of scientific language was one of the reasons they were constructed as knowledgeable. It was a source of their authority in the classroom. The students' comments are consistent with research by Lemke (1990, p. 45) who found that 'experts' who talk science are able to convince others that they are smarter. The students further reported that their perception of some students as being 'bright' inhibited them from fully disclosing their ideas in the classroom, and hence impacted on their assessment in that setting (see section 5.4).

Student perceptions of school science also shaped their engagement in formative assessment because of their view ideas could be judged right (or wrong). This view of science appeared to constrain them from asking questions and thereby disclosing their thinking to each other and the teacher for fear they might be judged as wrong. It limited the ideas available for discussion and greatly restricted teachers' knowledge of student ideas as the impact of feedback that indicated they were wrong was compounded by the public nature of classrooms.

In review, student comments indicated they considered school science had its own language and levels of explanation for phenomena as well as right and wrong answers. This was considered to influence student ability to understand teacher feedback and their willingness to disclose their ideas.

5.6 Formative assessment as an activity teachers engage in for a variety of purposes

A fifth aspect of students' experiences and perceptions of formative assessment was that it was an activity teachers engage in for various and often conflicting purposes which have different effects or consequences. Student comments about teacher assessment purposes arose when they reflected on lessons in phase 2.

Students considered the purposes for teacher assessment purposes were to: (i) manage student behaviour, (ii) obtain information for reporting, (iii) inform teaching and enhance student understanding, and (iv) as a check on student understanding. The students' comments indicated they were often uncertain about why their teachers assessed them.

Students believed teachers assessed them to manage their behaviour. This took the form of checking their books to see if they were working (Case study 4 and 6) and if they had completed their homework and questioning them to check whether they had been listening. For example, two students claimed:

S56 Teachers ask questions to let you know that you have not been paying attention. 'What have we just been talking about?' 'You weren't listening were you?'

S54 What did I say? (S54,56/I/95b)

Some students claimed that another reason teachers had for assessing them was to obtain information for reporting. These students said this was why they had end-of-unit assessments. In addition, three students claimed that teachers shared information that apparently had been elicited for the purpose of helping them in the classroom by talking the staff room. They considered this had a long term effect as it influenced how other teachers viewed them:

The thing is teachers do talk amongst themselves in the staff room .. and it gets around that [a student] didn't know what she was doing in science and she is not good at this ... and so the teachers will go back with that attitude. And it ... sticks with that person. (SG91/L6/96)

Many students claimed teachers assessed them in order to inform their teaching. This was the main reason students gave for teacher assessment during observed lessons. This was, for example, the reason the seven students of Teacher 7 gave for her asking them to explain how a hot air balloon worked during the first lesson of the observed unit. The students' view was this assessment helped enhance their learning. Some students considered that their teachers assessed them during lessons and at the end of a unit to check on their understanding (Cameo 15).

The students considered teachers assessed them to “check” on their understanding, that is to see if they had the “right idea”. A representative comment on this teacher assessment purpose was:

She came and looked at our books. She asked us what we had been doing just to check if we understood and were doing it right. (SG81/L3/96)

The students also considered teachers assessed them to find out about their learning for the purpose of helping them understand ideas. This was a reason given for teachers "coming around" to talk to them while they were working on an activity (Cameo 9 and 12).

The students were emphatic there was a distinction between the teacher assessment purposes of checking on their understanding and finding out what they understood. One student described this difference thus:

I like it when she comes to see if we are OK. With checking you are more worried that you will be wrong. (SG91/L4/96).

Cameo 15 clearly illustrated student responses to these two teacher assessment purposes. Student concerns with teachers looking at student books arose in part because they were not sure if the teacher was judging their work (Section 5.4.1).

The students indicated they found assessment to be a complex process because not only did teachers have various assessment purposes, they sometimes conflated these. Moreover, purpose often emerged only when the teacher reacted to what was disclosed. They recognised that when teachers asked, “Do you understand?” it could be out of genuine interest in their ideas, to check they had been paying attention and/or as a routine interrogative statement at the end of an explanation. One student explained their perception thus:

S92 I think some people get offended because they feel the teacher may target them.

Res Because they’ve been naughty or?

S92 Yeah, or because they constantly haven't done their work. I think the teacher just needs to find out if you understand it and its ... for your own good. It is not for them to say "Ha, ha, I'll get back on you and pick on you in front of the whole class." It is just for them to find out. (SG91/I/96)

The students also recognised, that the consequences of teacher assessment were not necessarily immediate. For instance, one student said she tried not to ask too many questions in case her teacher reported to her parents that she did not understand or listen (S53/I/95b).

The match between teacher and student perceptions of the purpose for an assessment were of special interest because the students responded differently depending on how they perceived teacher assessment purposes. The data revealed there were times when teachers and students attributed the same purpose to assessment tasks and activities, but there were also times when their perceptions of purpose differed. An instance of a time when a teacher and students attributed the same purpose to an assessment task occurred when Teacher 9 assigned her class a sorting exercise (Cameo 10). The teacher and students considered the teacher intended to find out whether the students understood the notion of controls for the purpose of helping them if they did not (T9/FN4/96; S5/T9/96). An instance of a mismatch between teacher purposes and students' perceived purposes was observed that involved the same teacher. The teacher planned to formatively assess the students' understanding of the notion of orbitals. The students did not identify the task as an assessment activity because the teacher's focus was on helping them (Cameo 9).

Cameo 15 illustrated how the issue of assessment purpose was further complicated by different students attributing their teacher with different assessment purposes for the same assessment action. Thus, assessment purpose can be construed differently by different classroom participants, which in turn influences the way they interact.

In summary, the students considered teachers assessed them to manage their behaviour and to report, check on and enhance their learning. They sometimes

experienced these purposes as conflated and contradictory. Uncertainty about purpose was reported to cause them to limit their interactions and hence opportunities for learning and formative assessment.

5.7 Student construal of formative assessment as a meaning making activity

The sixth aspect of student perceptions and experiences of formative assessment was that it was a meaning making activity. Their comments and actions indicated they were active and intentional participants in formative assessment because they experienced formative assessment as a meaning making activity, in which the meanings made were available to others to see. The meanings made by formative assessment included what counted as a legitimate scientific explanation (Cameo , 4, and 15) and what was valued as relevant to school science (Cameo 2: Soil composition). They also included the perceived reason for task engagement. This was highlighted in Cameo 5.

Formative assessment also signalled who was recognised and therefore construed as important to the teacher (Section 5.2.2). It influenced how students were viewed by others as a learner. Formative assessment, even informal formative assessment, influenced students' view of themselves as competent. This was illustrated by the student who explained:

The teacher might say something to you and that will just totally set you off and you will think "Oh, I just can't do this." (SG91/L9/96)

The students claimed this influence had long term consequences because they considered teachers were "really important people because they are shaping your education, the rest of your life for you." (SG91/L6/96). The influence of teacher formative assessment on how students viewed each other was implicit in the concern of all the students in phase 2 who thought they would be judged "dumb" or "stupid", or even worse "laughed at" by their peers if their actions revealed a lack of understanding. For this reason students were concerned to be "right". This is illustrated by the following cameo.

Cameo 16: Mystery boxes

The class of Teacher 8 discussed their concern to be seen to be “right” with her after an activity that required them to identify the objects inside nine “mystery boxes”. The researcher recorded in the field notes:

Nine cardboard boxes, each containing a small object such as a paper clip, were taped shut. The task was to identify the objects by inferring their physical properties. At least half the class looked inside the boxes. When the teacher asked why they had done this a student replied: “I wanted to be right”. The teacher reminded him she had been interested in his thinking, not the “right” answer but the class said they had not wanted others to think they were wrong. The class told her they were "embarrassed", "scared" of appearing "stupid" and “the only one who didn't understand" if their answers were not “right” (T8/FN8/96).

This cameo, along with many of the examples provided in this chapter, highlights that learning and the formative assessment of it has interdependent cognitive, social, emotional and relational effects or meanings. Thus understood, formative assessment involves and contributes to student learning, engagement, feelings and relationships. Student concerns with social and relational effects of formative assessment have serious implications for formative assessment that relies on both the teacher, and students being able to gain access to robust information on student thinking.

5.8 Summary

The student comments and actions reported in this chapter construe formative assessment as embedded in ongoing interactions with teachers and peers. They highlight the situated significance of taken-for-granted teacher actions such as looking at student books, informal questioning, assessing only some students, recording only some ideas on the board and of moving onto new activities and ideas.

Student comments and actions construe themselves as active and intentional participants in formative assessment. They indicated they assessed their ideas for

coherence and for agreement with those of the teacher and “brainy” peers (who were seen as having the authority to determine what was taken-as-science in the classroom) and with empirical evidence. However, the students reported they pursued learning, work load and social-relationship goals that formed interrelated experiences for them. It seemed that they often pursued social and relationship goals at the expense of learning goals in a manner that led them to limit the disclosure of their ideas in situations and to people they viewed as sources of potential harm.

Two learning goals having significance for student participation in formative assessment were distinguished - to understand ideas and to complete tasks. Students who had understanding as a goal, described formative assessment as a joint teacher-student responsibility and preferred feedback in the form of suggestions. These were said to keep them thinking and to allow them to build on their own ideas. Mutual respect, communicated by such feedback, was identified by these students as mediating their interactions with teachers. These students also spoke of teacher feedback as indicating to them that they were on the “right track” indicating they considered a particular understanding was to be achieved. Students with task completion goals thought it was the teachers’ responsibility to ensure they did this and they preferred feedback that helped them achieve this. Alongside this it appeared the students appreciated their teachers (and peers) assessed them for a variety of purpose(s) and that these purposes had different consequences for them and their learning.

The trustworthiness of teacher and peer responses to what was disclosed was identified as a key factor influencing students’ willingness to disclose their ideas and interests both when asked and through interactions they might choose to initiate.

Student perceptions of school science were said to mediate their involvement in formative interactions. Learning the language of science - the “big” words and diagrams - was seen as an essential part of learning science but these words were considered a potential barrier to learning. Teachers (and peers) who used language they understood were considered to provide more useful feedback.

Overall, student comments suggested they experienced formative assessment as a social, situated, intentional meaning making activity. The implications of this for a theoretical account of formative assessment with respect a sociocultural view of learning is elaborated in the next chapter.

6. The nature of formative assessment in the classrooms

6.1 Introduction

In Chapter 4, key aspects of formative assessment in each of seven classrooms were identified. These aspects were that teacher formative assessment was shaped by the setting and realised through the use of tasks and interaction and that it involved criterion, student and care referenced judgements and actions that were generally consistent with the teacher's view of teaching, learning and assessment. It seemed that formative assessment was an activity that shaped what counted as being a student and as knowing and doing school science. In Chapter 5 student perceptions and experiences were mapped out. The data presented indicated that students perceive and experience formative assessment as embedded in and accomplished through situated interactions in which they are active and intentional participants. Disclosure, the multiple and contradictory purposes teachers and students have for participating in formative interactions and the nature of the meanings that formative assessment contributes to were highlighted in this chapter.

This chapter uses data from Chapter 4 and 5 and additional data from the observations and teacher development days (Bell & Cowie, 1997) to form a view of the formative assessment that prevailed in the ten classrooms. Section 6.2 describes the process of formative assessment as observed by the researcher and perceived and experienced by the teachers and students. Sections 6.3 to 6.7 sketch out the factors that situated formative assessment and contributed to its construction. The identified factors were: the intentions of the participants (Section 6.3), the setting (Section 6.4), the influence of the participants as actors (Section 6.5) and the meanings that were made (Section 6.6). These factors were interrelated and exhibited within the classrooms in a range of ways so that formative assessment was accomplished, experienced and perceived by the teachers and students as a complex activity (Section 6.7). Section 6.8 summarises the chapter.

6.2 Formative assessment was accomplished through action and interaction

An analysis of the case studies, student views and teacher development day data indicated that formative assessment was accomplished through student and teacher action and interaction. Student perceptions and experiences of teacher formative assessment as being embedded in interaction were outlined in Chapter 5. Student concerns about peer reactions to their questions (Section 5.4) and descriptions of the help they gained from peers (Section 5.2.3) suggested they experienced formative assessment as an activity that involved peers as well as teachers. Chapter 5 also set out data to suggest that students engaged in formative self-assessment through the practices of asking questions of teachers and peers, discussing ideas and looking at each other's books. This section elaborates on teacher perceptions, experiences and practices of formative assessment.

6.2.1 Teacher formative assessment

Formative assessment was seen by the teacher as an on-going, everyday event:

Without formative assessment, teachers do not function effectively. So it's your on-going, day-by-day, every-day assessment (TD4/95/11.44)

The classroom observations suggested and the teachers confirmed they used two forms of formative assessment. These were planned and interactive formative assessment (Bell & Cowie, 1997; Cowie & Bell, 1999). Both involved action and interaction.

Planned teacher formative assessment

The teachers planned in advance to elicit information on their students' learning. The planned formative assessment tasks used before a unit included pre-tests (Teachers 5 and 9), recorded explanations (Teacher 7), a recorded brainstorm (Teachers 1, 4 and 6) and model making (Teacher 10). The planned formative assessment tasks used by teachers during a lesson were quick tests at the beginning of a lesson (Teacher 3), written exercises for individuals (Teacher 9), homework exercises (Teachers 7, 9 and 10), focus questions for whole class discussions (Teacher 5 and 7), peer assessment (Teacher 2) and student self-

assessment (Teachers 1 and 2). The planned summative assessment tasks used towards the end of a unit were tests (Teachers 3, 4, 5, 6 and 8), self-assessment (Teachers 1, 2, 4, 5 and 6), a flow diagram of an experiment (Teachers 4 and 6), making a model (Teacher 7), a verbal report to class (Teacher 5), the production of a pamphlet (Teacher 8) and the collection of student books (Teachers 4, 5 and 6). As the teachers often interacted with the students while they worked on the tasks, their planned formative assessment generated permanent and ephemeral evidence of student ideas. The students and the teachers also negotiated the meaning of teacher questions. For instance, Teacher 3 talked with the students while they were answering the questions he posed at the beginning of a lesson (Section 4.5.3), the students of Teacher 7 negotiated the meaning of her “before-views” focus question and Teacher 5 questioned students when they presented their work to the class. This interaction was important as it appeared to add to the fidelity of the information the task generated. For example, the students of Teacher 2 valued being able to talk with him while he was assessing them at the end of a lesson as they considered he had not always seen everything they had achieved (S24/I/96). The teacher considered that by talking to the students he could, “build a much better picture of what they [the students] are actually like” (T2/I/95a). Similarly, the students of Teacher 5 appreciated her questioning them when they presented two activities to the class as a summative assessment task. One student explained:

... when you present your thing to the class, if you run out of words to say, um, she asks some questions and then you remember again. [Is that helpful?] Yes, because sometimes you actually say less than you thought you said. ... when you’re standing up in front of the class, you’re really nervous sometimes and you don’t really know what to say. And so you sort of try saying the things you know in the most brief and general way you can. (S54/I/95b)

The emphasis the students placed on negotiation suggested they considered assessment information was not out there to be gathered but was generated through interaction.

Interaction as part of planned formative assessment also influenced whether or not students and teachers developed shared understandings of assessment questions and answers. Cameo 7 illustrated that this did not always happen. A student rejecting the teacher's marking her statement that "books give out light" as incorrect was another occasion when a student was unable to appropriate a teacher answer. The student told the researcher that people often said that "the light dawned when they read a book" but she did not speak with the teacher (T8/FN8/96).

The teachers' planned formative assessments tended to have a science curriculum focus. They wanted to know if the students had learnt and understood the science they intended them to learn. For example, through the spot tests, Teacher 3 elicited formative assessment information which he interpreted as some of his students not having understood certain ideas on electricity from the previous lessons (Case study 4). Hence, the teachers' interpretations of their planned formative assessments were usually science criterion-referenced. However, they also had an element of norm-referencing in that they were influenced by their expectations of the level of understanding which was likely with students of a particular age or level of schooling. For example, Teachers 4 and 6 stated the age of their students influenced the explanations about emulsifying they considered acceptable (Cameo 1). In another example, Teacher 5 taught her students about the existence of the plates on the earth's surface but took the concept no further, given the information she had elicited from them about their learning in earth sciences as 11 year olds.

The teachers acted on the formative assessment information they obtained in science and student-referenced ways. These actions tended to be with the whole class. They used empirical evidence, analogies, discussion and their own authority or the authority of texts to persuade the students. For example, Teacher 7 acted on the initial formative assessment of student ideas about how hot air balloons work by requiring them to perform five experiments to address their alternative conceptions and Teacher 5 encouraged students to research the composition of soil (Cameo 2). Another science-referenced way the teachers acted on planned assessment information was to indicate what was valued as a learning outcome. For example, Teacher 3 acted to confirm the scientific model for electric current

when he found out that many of the students had a view of electric current being “less when it had passed through the light bulb” (T3/FN5/96).

The teachers viewed actions to ensure students completed tasks as they intended to be science criterion-referenced. This was because the tasks they used were those they considered would best mediate the students' understanding towards a particular science concept or they wanted to ensure the students had common experiences. For example, Teacher 8 checked to see if the students could use a ray box and position the lenses before she left them to observe and record their findings (Cameo 5) and Teacher 7 acted to ensure the students had the same experiences of five experiments (T7/FN5/96). Twelve students indicated that it was important that their teachers assessed task completion in an ongoing way. They spoke disparagingly of teachers who did other work while they were supposed to be working on tasks. They interpreted this action as signalling the task was not worthwhile. This perception is of concern when the intention is for students to actively consider and reconsider their understandings as a consequence of engaging in the task.

The teachers' second way of acting on the planned formative assessment was to act in a way that was referenced to the students. Student-referenced action built on how individual students' science understandings were changing over time. For example, Teacher 8 provided students who had finished the ray box activity, an extension activity of using two prisms 'to produce a rainbow and then combine the colours' (T8/FN7/96). The action was given with reference to these students' need for further focused activity and learning.

Overall, the planned formative assessment was seen by the researchers and teachers as a cyclical or spiral process that involved eliciting, interpretation and action on information. At teacher development day 4, it was described thus:

We decided it was a cycle, and the cycle starts with a student activity of some sort, data gathering happens ... the teacher needs to be reflecting on what is happening. ... the teacher and the students will formulate the direction that they're going, and then you're back to the beginning with a student activity of some sort... there is feedback going on ... (TD4/95/12.6)

Interactive formative assessment

The second form of formative assessment identified by the researchers and teachers was interactive formative assessment. It consisted of noticing, recognising and responding to student learning. Interactive formative assessment was embedded and accomplished through taken-for-granted teacher actions such as teachers “going around” and observing and questioning students in whole class, small group and one-to-one situations while they were engaged in learning activities. It had the potential to occur any time students and teachers interacted but depended on the teachers noticing, recognising and responding to student thinking. The teachers prepared to do interactive formative assessment although they could not plan for or predict what exactly they and the students would be doing.

In interactive formative assessment, noticing was associated with the teachers’ awareness of individual student learning. Teacher 9 explained noticing thus:

I tend all the time to be noticing what ... individuals are doing (T9/EOY/95)

Through their interactions, the teachers were able to take note of the actions and interactions of some but not all of the students. The teachers noticed different information from different students at different times. Hence, noticing differed from eliciting information in planned formative assessment in that the information gained was usually ephemeral, not recorded, and the process was faster. The ephemeral information included student comments and questions and how they did practical activities, how they interacted with others, the tone of discussions and their body language.

The information the teachers noticed was related to the students’ science, social and personal development. The noticing was informed by teachers’ professional knowledge. At a teacher development day they explained this influence thus:

Because the knowledge of how to teach is what makes that successful. ... you’ve got to have confidence in your ability to teach.

And that's all your other skills ... those you actually can't do without.

...Yeah, it's knowing how to handle the students, isn't it?

I still think that the knowledge base of the subject has got a place, though.

I think, too, if your knowledge is at a reasonable level, you can take advantage of the one off situations that sometimes happen. Whereas if it's not there, you can't take advantage at all.

And the more you teach, the better you become. (TD9/96/26.41)

During practical and written work, the teachers noticed whether or not the students performed the task correctly and successfully, and if they were making the intended sense. For example, Teacher 5 noticed that some of her students did not have a scientifically acceptable concept of heating and cooling (Cameo 4); Teacher 9 noticed that some students did not understand the notion of controls (T9/FN8/96); and Teacher 7 noticed that some of her students did not know about the properties of the substances she had asked them to separate (T7/FN1/96; Chapter 1). The teachers also noticed what sense the students were making (whether it was the intended learning or not). For example, Teacher 7 noticed that some of her students requested equipment to filter oil and water to separate them (T7/FN1/96). The teachers also noticed aspects relating to student personal and social development. For example, Teacher 9 noticed that a student who was not included by the other students, wished to contribute to a whole class discussion (T9/D6/96).

The second part of interactive formative assessment was that of recognising. The teachers commented that while they were observing, talking to or listening to a student(s) they would notice something and recognise its significance for the development of the students' personal, social or science understandings.

Recognising may be differentiated from noticing in that it is possible to observe and note what a student does without appreciating its significance. At times, the teachers only appreciated the significance after the event. For example, it only occurred to Teacher 3 after a lesson that a student was using the term "fuse" as related to the fuse of a bomb, rather than to his meaning of an electrical fuse in a household circuit (Cameo 7).

The third part of interactive formative assessment was the teachers responding to what they had noticed and recognised. The responding by the teachers was similar to the acting in planned formative assessment in that the teachers responded in care, student and science referenced ways. Care referenced responses were those taken to maintain and enhance their relationship with a student and/ or the way a student viewed science. During interaction, a science referenced response was a response to mediate a students' learning towards that of a scientist. A single response might have one or more of these aspects in it. For example, Teacher 7 noted and recognised one student's reluctance to accept her advice on how to separate two substances (Cameo 13). The teachers also acted in student referenced ways by drawing on their knowledge of students in responding. An example was when Teacher 8 compared scientific observation with the skills needed to be a fashion model (T8/FN/96), Teacher 7 used different language with different students and Teacher 5 questioned students and suggested further activities to get them to engage in thinking about their ideas of heating and cooling (Cameo 4). Their actions often drew on the context. For example, Teacher 5 suggested a student look at another map from her desk when she couldn't identify the tectonic plates on a map centred around Africa (T5/FN11/95b).

On some occasions, the teachers responded to interactive formative assessment information by changing from interacting with a random sample of students to acting with all the students. This occurred when a student had a significant scientifically unacceptable conception or when a number of students displayed similar alternative conceptions of the science or of the purposes or requirements of the task. The interactive formative assessment response that they took often involved repeating an explanation or activity that had been successful with a student or a small group (Cameo 14).

Another response by the teachers was to deliberately elicit information from all the students. For example, Teacher 7 took this action to check on and confirm all the students understood the notion of density (Cameo 15). In order to respond to interactive formative assessment in this way, the teachers had to be familiar with a number of assessment strategies and with the forms of information they were able to elicit. When a teacher moved from randomly noticing formative assessment

information in one lesson to eliciting information from all students in the next lesson, this was considered planned formative assessment.

Teacher reports of formative assessment as a reciprocal activity

The teachers emphasised that they experienced both forms of formative assessment as a joint and reciprocal activity. They considered their actions and interactions functioned as information for students just as student actions and interactions served as information for them. On teacher development day seven, they described the reciprocal nature of formative assessment thus:

Think of it [formative assessment] from the kid's point of view, the kid gathers information from what you've given them already, they filter it, decide what's relevant to them, they interpret what they need to do however they like, they act on that information, and then from whatever you do or from whatever things happen, they gather more information and so on.

So it works exactly for them. It's just that our acting becomes their gathering information points.

Whatever we do they get the information from.

And their acting is our gathering.(TD7/96/20.45; TD7/96/20.59)

The teachers and researchers considered the joint and reciprocal activity could be represented thus:

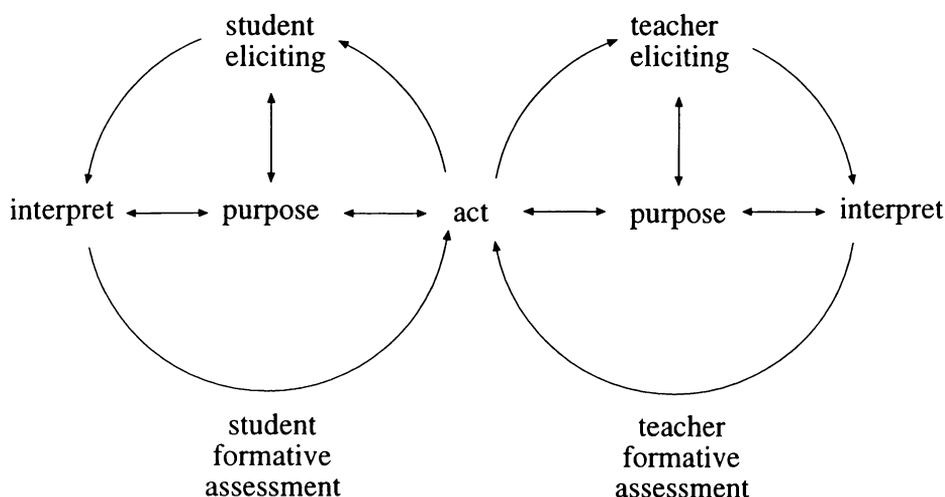


Figure 6.1: Teachers' and students' formative assessment (TD7/FN/96).

The teachers considered the reciprocal nature of formative assessment was illustrated by overlap between teacher and student actions: teachers and students respond to each others' actions.

Student reports of formative assessment as a reciprocal activity

The students' comments also highlighted the reciprocal nature of the assessment process. Their concerns about disclosure (Section 5.4) indicated they were aware their actions served as information to peers and the teacher. However, their actions indicated they not only responded to intentional teacher feedback (Cameo 5) they also used the teacher action of assessing or not assessing and of providing feedback to a particular student in a formative way. These actions were construed to indicate what and who was important to the teacher and hence of value in the classroom.

To summarise, the student and teacher comments and actions suggested that formative assessment involved the exchange and action on information and was a process that was embedded in student-student and student-teacher interactions. Teacher formative assessment was accomplished through the planned use of tasks to elicit information on student understanding of science followed by the interpreting of and action on the data generated. Teacher formative assessment was also accomplished through teacher interaction with students while they were engaging in learning activities. In this case it followed a process of their noticing, recognising and responding to enhance the development of students' social, personal and science understandings and skills. Thus understood, formative assessment was a social activity. In the next sections factors that shaped teacher and student formative actions and interactions and hence their assessment opportunities and actions are set out.

6.3 Formative assessment was an intentional activity

An aspect of formative assessment highlighted by the analysis of the case studies, student views and teacher development day data was that it was an intentional activity. It was undertaken for a purpose. The students and teachers initiated and participated in formative assessment to establish, maintain and manage the cognitive, social, relational and emotional aspects of classroom life.

6.3.1 Student formative assessment purposes

The students' comments and actions construed themselves as intentional participants in formative assessment in pursuit of a range of situated social and learning goals (Section 5.3). It seemed they sought to interact with others in ways that maximised the learning and social benefits of assessment while simultaneously ameliorating possible negative social and emotional consequences in a situation where the teacher and their peers are influential but their influences may be contradictory. This multiplicity of student goals makes formative assessment a complex process for teachers as it suggests that student actions are not necessarily a source of robust information about students' current understandings and interests.

6.3.2 Teacher formative assessment purposes

The teachers described their assessment purpose as pivotal in determining the nature and timing of their formative assessment (Bell & Cowie, 1997; Cowie & Bell, 1999). Formative assessment through planned tasks was said to be driven by the curriculum. They explained :

... what is driving your planning in that [planned formative assessment] is the curriculum plan that you might do that translates to the teaching.
(TD10/96/28.53)

The planned formative assessment was said to provide them “general” or “blunt” information that was valuable in informing their interactions with the class as a whole with respect to “getting through the curriculum”.

In contrast, interactive formative assessment was described as “finer tuned” with “lots of little purposes to support the major picture/purpose” (TD10/96/28.54). It was focused on students and their learning rather than the curriculum.

The teachers' formative assessment purposes were not fixed. They emerged and evolved in response to what the students were doing and the sense they were making. They moved from a focus on the curriculum to responding to student ideas by switching from planned to interactive and interactive to planned

formative assessment. On teacher development day 10 the switching process was described thus:

Still thinking about the links between the two [forms of formative assessment] ... When does one switch in and the other switch off and what kick starts [it]. We know what kick starts the planned one, you plan to do it. What's the link there and does it ever go back? (TD10/96/28.29)

... You start out with your planned purpose, and you're teaching along and you notice something happens which changes what happens during the lesson which gives you a new purpose, which will lead to your next planned purpose. (TD10/96/28.31)

An example was Teacher 9 not being able to understand her students' answers to what would serve as a control and her moving to talk with individuals (Cameo 11). In other examples, Cameo 2 illustrated how Teacher 5 moved from interactive to planned formative assessment, Cameo 15 illustrated a move from interactive to planned formative assessment and Cameo 5 illustrated how teacher formative purposes evolved over a lesson.

The teachers' formative assessment purposes also evolved over a unit. Case study 6 illustrated how a teacher's assessment purposes might change from the eliciting before-views to explaining and using the notion of density.

Teacher formative assessment often intermingled and overlapped assessment for reporting, social management and learning. For example, the teachers stated they obtained information (usually quantitative) for reporting purposes through the use of planned activities but that their written comments were usually based on information gathered through their formative interactions (Bell & Cowie, 1997). The teachers assessed the students to ensure they used equipment in a safe way to meet their professional and legal responsibilities for student health and safety (as per the Health and Safety Act) and as part of fostering the development of practical skills (Case study 1). They assessed task engagement and completion to ensure individual students and groups did not disrupt others (a management function) and because they considered task completion would enhance student

learning (TD7/96/20.70, 20.71). The teachers assessed the development of co-operative skills as a focus for curricular learning and as a prerequisite for meaningful learning when they wanted students to work together to participate in the social construction of knowledge (Case study 4, 5, 6).

The various teacher assessment purposes contributed to the complexity of classroom assessment for the students because different teacher assessment purposes had different social, emotional and cognitive consequences for students, some of which they found undesirable. The students indicated they valued assessment which focused on enhancing their learning (section 5.2). For example, one student said it would be “like being away” and another that it would be “a mess” if teachers did not assess students. However, the students associated being “targeted” and “picked on” through teacher assessment for management with teacher unfairness and the loss of personal dignity. They claimed that assessment of their understanding which resulted in public feedback (verbal and non-verbal) that their answers were wrong made them feel ashamed and embarrassed, and led their peers to conclude they were “dumb” and consequently “tease” them. One student explained this:

If she asks from the whole class you don't want to talk much. And then teasing from your friends. And that feels stinky. (SG82/L5/96)

For students the complexity of the situation was compounded because what the teacher intended was often ambiguous and emerged only when the teacher responded to what a student disclosed. This occurred in Cameo 15 where the teacher's assessment purpose was evident only from her evaluation of responses. They recognised too, that the consequences of teacher assessment were not necessarily immediate (Section 5.4.3).

The various and overlapping teacher assessment purposes sometimes led to student confusion about the purpose for performing an activity. The overlap between task completion for learning and management and between formative and summative purposes was particularly problematic in this regard as was illustrated in Cameo 15. The link between task completion and understanding was complex because sometimes the desired learning was explicitly linked with task

completion. This was the case with the scientific skill of observation (Case study 1) and the construction of the hydroponics kit in the unit observed with Teacher 2 (T2/FN1-7/96). On the teacher development days, the teachers debated the links between successful task completion and learning. They considered that because they used tasks in the belief they would enhance student learning, it was important to them the students completed the task even though they appreciated successful task completion did not necessarily indicate understanding.

Confusion about purpose also occurred when a teacher's learning goals were not immediately obvious to the students. This confusion was illustrated by the student who questioned the purpose of a flame test activity:

... the one [flame test activity] we just did ... we didn't know what we were doing it for ... so we didn't know if it was something to pass the time or not. Sometimes we do experiments and we don't follow them up or anything. It is just an experiment. (S94/I/96)

Her friend explained to her the teacher had said she would link the task to the periodic table in the next lesson. On this occasion, the teacher's knowledge of the future direction of student learning led her to emphasise task completion for reasons which were not obvious to the students. The impact of teacher long term goals is illustrated in the following cameo.

Cameo 17: Ruling up the net

The students of Teacher 2 were required to make a model and then a container for a hydroponics kit. Having worked out the dimensions of the container their task was to transfer their measurements to a piece of metal. This cameo describes one student's attempt to do this. Her actions were field noted as:

The teacher demonstrated how to transfer measurements onto the metal at the beginning of the third lesson. He suggested the students (i) draw the outline for the safety edge and then mark the lines for the base and sides; (ii) make all the measurements from one place; (iii) have the zero on the ruler on the outside edge of the tin; (iv) use at least three points to draw a straight

line and (v) use a sharp soft pencil. He insisted the students to show him their net before they cut it out (T2/FN3/96).

Different students worked on this task over five lessons (T2/FN3,4,5,6,7). During this time the teacher sat at one table, the students approached him to show their work, he checked their measurements, crossed out the lines that were inaccurate, told the students how inaccurate they were (three to six mm) and suggested they try again. The teacher and students did not discuss how the students had performed the task. Some students completed this task in one lesson.

One student began this task towards the end of lesson four. When she ruled the lines she did not (i) use the zero on the ruler, (ii) keep the ruler parallel with the edge of the tin, (iii) use three points to draw a line or (iv) measure in order to minimise errors. Over the three lessons she worked on the task she showed her work to the teacher five times. He progressively approved her measurements. (T2/FN4,5,6/96).

The student, when she was interviewed, said she was “sick of going up” to the teacher for help (S23/I/96). It appeared her frustration was due to not knowing the teacher’s criterion for accuracy and why accuracy was important. She claimed the teacher used different assessment criteria with different students. Altogether, three students alleged the teacher had approved drawings with errors larger than those he had asked them to correct for students who were “teacher’s pets” or “boys like him” (S23,25,26/I/96). It seemed that the teacher’s unjustified (to them) use of his authority to judge their work undermined their relationship with him in a way that also had the potential to disrupt their relationships with their peers.

The teacher explained to the researcher, on her request, that cutting and bending increased inaccuracies in the measurements and so an accuracy of 1-2 mm’s was required at the drawing stage (T2/D4/96). It appeared that because the teacher’s criteria derived from his knowledge of a future problem his reasons for focusing on accuracy in the moment were not obvious to the students.

To summarise, the teachers and students initiated and participated in assessment for various, overlapping and often contradictory purposes. The similarity in teacher and student purposes and in the purposes they attributed to each other is of interest because it seems both groups sought to realise social and learning goals which they experienced as interdependent and interrelated. The variety in and emergent and ambiguous nature of some of the goals and the contradictions within and between teacher and student goals made assessment a complex activity.

6.4 Formative assessment was embedded in a setting: it was a situated activity

The analysis of the case studies, student views and teacher development day data suggested that formative assessment may be viewed as a situated activity - it was an activity situated in the setting in which it occurred and the formative assessment was shaped by the setting. The aspects in the setting that shaped how formative assessment was accomplished were the community, the institution or school, the classroom, the curriculum and the temporal. In this section these aspects are conceptualised as interrelated planes. Each is foregrounded in turn and its impact on classroom formative assessment is discussed. The notion of foregrounding is used because it allows each of the planes to be considered separately without losing any of them (Rogoff, 1995, p. 140).

6.4.1 Formative assessment was situated by the wider community

The broadest of the planes in which formative assessment was situated was that of the wider community. The community plane highlighted the influence of the reporting and accountability functions of classroom assessment. At the beginning of the study, the teachers identified the need to obtain information for reporting to parents and other teachers and accounting for student “progress” to the school and Education Review Office as an assessment issue (Cowie & Bell, 1995a). The teachers were concerned to understand exactly what was expected of them as policy documents from with the Education Review Office and the Ministry of Education were seen as ambiguous. This concern was raised as an issue for formative assessment because the teachers were worried that the demands of those

outside the classroom might lead to summative assessment dominating their lessons and taking time from teaching and learning (Cowie & Bell, 1995a, p.31).

6.4.2 Formative assessment was situated in the school or institution

The institutional or school setting was the second plane in which the formative assessment was situated. This plane foregrounded the influence of the organisation of schools, the physical setting and school reporting procedures on teacher and student actions, interactions and relationships, and hence on their formative assessment opportunities.

The first way the school plane shaped formative assessment was through *differences in school organisation*. Three interwoven elements were identified. They were (i) the impact of a specialist teacher, (ii) the implications of this for teacher control over the daily programme, and (iii) where the lessons took place. As is usual in Intermediate schools, four of the Year 7 and 8 teachers were responsible for student learning in all the curriculum areas (except technology). (The fifth Year 7 and 8 teacher taught a seven week module on materials technology to a large number of classes). They assessed art and reading as an integral and legitimate part of the observed science units. The Year 7 and 8 teachers (Teachers 1,2,4,5,6) formally assessed their students' personal, social and science development (Cowie, Boulter & Bell, 1996, p. 30; TD3/95/7.22, TD3/95/7.25). In contrast, the five Year 9 and 10 teachers taught the observed classes for science only. They assessed students' personal and social development informally when they interacted with or observed the students. One of them explained at a teacher development day:

I would tend to assess ... the three science areas quite formally over the year.

The personal and social skills, it's only an informal assessment ...
(TD3/95/7.19)

School organisation also influenced formative assessment by an impact on the *relationship between teachers and students*. The Year 7 and 8 teachers considered that teaching the students for most subjects meant they were able to find out more than the Year 9 and 10 teachers about student interests and ideas

(Case study 1). The importance the teachers attached to knowing their students was highlighted during the observations with Teachers 2 and 9. These teachers were observed when they first taught the case study classes and much of their assessment was focused on getting to know their students. Teacher 2 had designed a formal assessment system to help him do this because he only taught them for seven lessons (T2/I/895a; T2/I/96). Teacher knowledge of students is important in student-referenced interpretations and responses such as when Teacher 7 used different language for different students (Case study 6).

The school organisation also determined the nature of teacher control over the students' daily programme and this shaped possible teacher formative assessment actions. Teacher 5 used her control over the programme to extend a lesson when she found students held alternative conceptions (Cameo 4). This action allowed the students to continue to share and debate their ideas until they reached a consensus. It was not available to the Year 9 and 10 teachers as their science lessons were timetabled by the school. The longer duration of the Year 7 and 8 lessons (one and a half to two hours) seemed to produce a less hurried atmosphere. Fourteen Year 9 and 10 students, but no Year 7 and 8 students, indicated that an unhurried atmosphere suggested to them that understanding was both important and possible (Cameo 11). It was notable that the Year 7 and 8 students discussed what they had learned during the units in terms of "thinking more" about ideas rather than learning for tests.

The practice of Year 7 and 8 students and teachers spending most of the day in the same classroom also influenced assessment. Teachers 4 and 6 used continually updated displays of student work to model what they valued (Case study 1). This action was not available to the Year 9 and 10 teachers as their students were only in their classrooms during science.

The second way the institutional setting shaped assessment was through *the nature of the classroom itself*. The Year 7 and 8 lessons took place in a non-specialist room. This meant these teachers had limited access to empirical evidence as a source of immediate persuasion. For example, Teacher 4 (a Yr 7 & 8 teacher) needed to collect a set of emulsions overnight rather than immediately when she wanted to persuade her students that detergent (and not water

or oil) was an emulsifier (Case study 1). In contrast, Teacher 7 (a Year 10 teacher) was able to provide her students with oil and water to immediately test whether they could separate the two substances by filtering (Case study 6).

Classroom furniture and its arrangement framed teacher and student assessment opportunities in ways that contributed to the nature of the process. Low desks facilitated teacher assessment by observation but increased the chances the teacher would be standing over students, something they disliked (Section 5.4). Grouped benches appeared to facilitate peer assessment through comparison of book work and discussion of ideas (Case study 2). This had the advantage of providing students with easy access to ongoing help but the disadvantage, given their preference for help from their peers, of reducing teacher access to student ideas.

School reporting procedures were a further way the institutional setting shaped assessment. This aspect was linked to the community plane. While reporting was not a direct focus of the study it highlighted differences in the roles students played in classroom assessment. Students in the Year 7 and 8 schools were actively involved in their own assessment and reporting. For instance, they all completed a summative self - assessment in the observed units. Student self-assessment was a component of the school-parent reporting system in four classrooms (Teacher 1,2,4 and 6) and students from two classes were involved in ongoing formative self-assessment (Teachers 1 and 2). Year 7 and 8 teachers reported to parents in informal but planned ways by requiring their students to show their parents their books. No self assessment or informal reporting of this sort was observed in the Year 9 and 10 classes. For the Year 9 and 10 students, assessment tended to be an activity teachers engaged in.

6.4.3 Formative assessment was situated by the classroom

The classroom plane was the third plane in the setting. It foregrounded how teacher and student formative assessment opportunities and experiences were shaped by the nature of teacher and student rights and responsibilities.

The first aspect of the classroom plane - *teacher responsibilities* - overlaps the community and institutional/school planes and is linked with that of assessment

purposes (Section 6.3.2). The teachers considered they needed to assess students to provide information to the school, parents and community about student learning, to inform their teaching and to enhance individual understanding (Cowie & Bell, 1995a). The teachers also considered they needed to assess student learning to enhance individual understanding and to ensure class coverage of the curriculum (as prescribed by the school and outlined in the *Science in New Zealand Curriculum* (Ministry of Education, 1993b). They indicated they experienced the contradictions and conflicts in these various responsibilities as a series of dilemmas. One teacher explained:

One of the dilemmas is this problem of ... managing the whole while focusing on the individual. Knowing about the individual while you're responsible for the whole class. (TD9/96/26.16)

Teacher 9 discussed this in terms of needing to decide what percentage of the class needed to understand an idea before she moved on.

The second aspect of the classroom plane was teacher *rights*. It was taken-for-granted by the teachers and students that the teachers were able to require students to disclose their ideas even though the students did not always wish to do this (Section 5.4.2). In addition, student perceptions that teachers were entitled to respect reduced the teachers' access to feedback on the efficacy of teacher actions (Section 5.4.2).

The students indicated that one consequence of teacher rights and responsibilities was that their actions had a *situated significance*. The students, as might be expected, reported teachers tested important ideas and said they concluded a skill or understanding was important if it was tested. Cameo 15 illustrated their sensitivity to the focus of informal teacher formative assessment. Likewise, the teacher recording only some student contributions on the board was considered to indicate which answers were "right" (S51,54/I/95a; SG71/L10/96).

6.4.4 Formative assessment was situated by the curriculum

The curriculum was the fourth plane in the setting that situated formative assessment. Within the study, the curriculum was defined to include those understandings, skills and attitudes the teachers were expected to foster, the activities used to do this and the tasks used to assess the meanings students were making. The curriculum plane foregrounded what the teachers assessed as valued learning and how the learning activities and assessment tasks they selected shaped teacher and student formative assessment opportunities.

The first aspect of the curriculum plane was what the teachers intended students to learn. In New Zealand, the official curriculum is set out in national policy documents (Ministry of Education, 1993a, 1993b). This curriculum is translated into units within the schools and then into lesson plans by teachers. The teachers noted that their goals for student learning acted to “filter” what they noticed within the busyness of the classroom (TD7/96/20.36; TD7/96/20.37). The teachers’ intended learning outcomes determined what they expected students to do and say and formed the basis of their science criterion-referenced interpretations.

In practice, as was illustrated in Case studies 1 and 2, the teachers assessed their students’ personal, social and science development (see Cowie, Boulter & Bell, 1996). Students’ personal development related to their learning about themselves as learners of science and to their asking questions, time management, motivation and self-assessment skills. Their social development related to their interacting with others (students and teachers); their leadership, group work, discussion and listening skills. For students, their science development related to the development in their knowledge and understanding of science and their ability to do science. The aspects that were assessed by the teachers in the science lessons were the science content (the body of scientific knowledge - the concepts and ideas of science), science context (the contexts in which the science is learnt and used) and science processes (those skills and processes used by scientists to investigate phenomena). Cameo 11 illustrated an emphasis on science processes, Cameo 5 illustrated a focus which moved from process to content and Cameo 7 illustrated a focus on linking scientific ideas to everyday contexts. The teachers’ broad formative assessment focus was consistent with the range of desired learning

outcomes outlined in the *New Zealand Curriculum Framework* (Ministry of Education, 1993a) and *Science in New Zealand Curriculum* (Ministry of Education, 1993b) and hence was linked to the community plane of the setting.

The emphasis teachers placed on students' personal, social and science development appeared to be a function of the institutional setting (section 6.4.2, TD3/95/7.9). All the teachers assessed students' science development but the Year 7 and 8 teachers assessed their students' personal and social development more often and more formally (TD3/95/7.24, TD3/95/7.22, TD3/95/7.25).

The emphasis placed on social, personal and science development varied within a lesson and across a unit (TD3/95/7.11; TD3/95/7.17; TD3/95/7.18). It varied with the learning goals for a lesson (TD3/95/7.11). The analogy was made by the teachers between their assessment of students' personal, social and science development and balloons that inflate and deflate. They noted that the social aspect often dominated the science (TD7/96/20.15). For instance, Teachers 4 and 6 noted that their students' lack of co-operative skills had restricted the nature of the learning activities they were able to use. The development of these skills was a particular focus for the observed science unit both as a desired learning goal and as a factor that supported the leaning of science.

The second way the curriculum plane shaped formative assessment was through the influence of the *learning activities and assessment tasks* selected by the teachers. The learning focus of the activities circumscribed the knowledge, skills and understandings students had an opportunity to represent or disclose. As one teacher noted, it was difficult to assess students' practical skills unless they were doing practical work (T9/D3/96). The social organisation of activities shaped the ways students could represent what they knew, who was assessed, the audience to student disclosure and students' opportunities to initiate formative assessment interactions. Planned formative assessment tasks usually provided opportunities for each student to represent the product of their scientific understandings and skills. They generated permanent evidence of student thinking - the teachers were able to read student test answers and book work and make written comments at their leisure. In contrast, while teacher formative assessment during learning activities allowed teachers to assess a wider range of skills and understandings

including students' co-operative and communication skills the information the teachers had access to was usually ephemeral - student comments, questions, actions and interactions. If teachers were not present when the information was noticeable or they did not recognise its significance it was rarely available to them at a later time. Hence, the teachers were able to notice information from some, but not all, of the students. They were able to access different information from different students at different times and so this form of formative assessment had implications for equity of student access to teacher assessment.

In the curriculum plane, the composition and size of audience was an aspect of the social organisation of activities that influenced teacher and student formative assessment opportunities. When students completed written activities the audience was usually only peers (friends who sat nearby) and the teacher. During whole class discussions, the audience was the whole class and usually only "confident" students voluntarily answered or asked questions. Moreover, the presumed audience was not always the eventual audience - even when students spoke privately to a teacher he or she sometimes disclosed their ideas to the class (section 5.4.3). Furthermore, in the intimate and public setting of the classroom student and teacher comments and actions could always be overheard. For example, Teacher 2 deliberately took advantage of the public nature of his teacher assessment of individuals to communicate what he valued (T2/EOY/95b). As was noted in Section 5.2.2, most students preferred small group or one-to-one interactions with the teacher and considered this situation provided the most disclosure of their learning. This view was supported by Teacher 5 who commented that when she wanted to find out what each student thought she used small group activities (T5/D4/95b).

The social organisation of activities influenced the opportunities students had to initiate formative assessment interactions. During small group work, the teachers usually circulated around the class and the students were usually able to approach the teacher informally for help at a time and place of their choosing. In one classroom, the teacher sitting in one place meant the students not only needed to approach him or her they also had to do so in a semi-public way. The other students knew where the teacher was and who was asking for help (T2/FN1-7/96).

In summary, formative assessment was situated by the curriculum plane.

This plane prescribed the focus for student learning and this circumscribed what it was possible for the teacher to find out. The nature of the learning activities and assessment tasks the students and teachers engaged in shaped what the students were able to disclose and the opportunities they had for doing so.

6.4.5 Formative assessment was situated in the temporal plane

The final plane in which formative assessment was situated was temporal.

Classroom assessment was situated in time in the sense that what occurred in the moment was constituted by and realised out of the past in anticipation of a shared future (Rogoff, 1995). Thus, this plane foregrounded the influence of the continuity in teacher - student relationships. The teachers and students, like people in everyday life, assessed each other and over time they developed mutual expectations and understandings and built up relationships which informed and enriched (mediated) their next interactions. These expectations and understandings are discussed in this section.

One way that formative assessment was situated in time was that teacher knowledge of a class and the individuals within it, developed over time. For instance, Teachers 4, 5 and 6 commented that the ability of their classes to work (and not work) together influenced the activities they selected and hence teacher and student assessment opportunities (Case studies 1 and 2). The “pictures” the teachers had built up of individual students influenced their formative assessment actions. For example, Teacher 7 said she had not probed a student’s answer because she was unsure whether the student understood floating and sinking other than relative to water and the student was very quiet and rarely spoke in class. Knowledge of students is essential if the teachers are to make student - referenced interpretations and take student-referenced actions. The teachers noted that at the beginning of the year, without this knowledge, it was difficult for them to undertake formative assessment (Bell & Cowie, 1997). They also commented they needed to be careful their expectations did not bias their assessment.

The students agreed that a benefit of the ongoing nature of teacher-student involvement was that teachers came to “know” them. That is, their teachers came

to appreciate their “level” of understanding and the language they understood. This meant, in their view, that teachers were able to “make better decisions” about how to help them learn. Their view was illustrated by the student who said:

And it gets easier for the teacher, as the year goes on because they get to understand the level of learning of the class. ... And of individuals in the class. So they can make better decisions on how ... to work the lessons and stuff to get people to understand easier and better. (S94/I/96)

Another way formative assessment was situated in time was that students assessed teachers and developed expectations of how they would act and react. Some student expectations of teachers were of long standing. For instance, the students reported the experiences of and the advice they had received from parents and siblings (Section 5.4.2). More specifically, the students said they assessed (Section 4.7.1) and came to “know” their own teacher (section 4.3.1). Their accumulated experience of teacher reactions and how they anticipated their current teacher would react shaped their willingness to interact with him or her. Their comments suggested that because teacher actions were unpredictable, they found teacher assessment to be a complex activity that they simultaneously desired more and fewer opportunities to participate in.

Formative assessment was also situated in time through student and teacher perceptions of the nature of school science. The teachers’ perceptions that practical work enhanced student understanding appeared to explain their use of practical work to challenge students’ alternative conceptions. This form of feedback was used by all the teachers. For example, Teacher 3 wired up a circuit with 2 ammeters, a bulb and a battery to demonstrate electric current is not consumed (T3/FN4/96; see also Cameos 1, 13,14). The value the students placed on practical work suggested that this form of feedback had the potential to persuade them to reconsider their ideas although this was not always the case.

Teacher and student perceptions that practical work was motivating (Case studies 1 and 3) were of interest when learning is viewed as an intentional, affective activity. In this case, assessment to support engagement and motivation is a legitimate part of assessment for learning (Case study 3). However, this does

raise the questions about the links between task completion and learning (Cameo 5).

A further way formative assessment was situated in time was through the continuity of teacher - student relationships. The teachers were concerned to maintain positive relationships with their students. Their care-referenced actions were intended to support and sustain their relationships with students and students' relationships with science in the long term. In addition, the teachers used their knowledge of what students would be learning in the future to adjust their short term learning purposes within the framework of their long-term purposes (Case studies 5 and 6). On some occasions, the students misinterpreted the intent of the teacher actions because they were not aware of their long term purposes.

To summarise, a review of the case studies and student views suggested that formative assessment was situated within the planes of community, the institution, the classroom, the curriculum (school science), and the teacher and students' interpersonal relations and time. It is suggested these planes are best viewed as being in an ecological relationship; that is they influenced and were influenced by each other. Assessment accomplished by the teachers and students in this study emerged from the complex web provided by these dimensions while simultaneously serving to construct and reconstruct them.

6.5 Formative assessment was accomplished by teachers and students as “actors”

The previous section described how formative assessment as an activity was situated by factors largely outside the students and teachers. This section focuses on teachers and students as participants or actors in the activity called formative assessment. It addresses the point that while it was unreasonable to separate formative assessment from the activities and contexts in which it takes place, it was also unreasonable to ignore the influence of teachers and students as participating individuals or actors. Student and teacher perceptions, knowledge and experience, choices, interests, concerns and relationships mediated their formative actions and interactions. The students and teachers simultaneously

created the setting for assessment, were part of the context for assessment, and participated in assessment. The ways teachers shaped and mediated formative assessment are discussed first as they dominated the classroom setting.

6.5.1 Teachers as actors in formative assessment

An analysis of the case studies and teacher development day data suggested that teachers as participating individuals shaped assessment in four ways. Firstly, through the influence of their institutionalised roles, rights and responsibilities. Secondly through the tasks they selected and the way they implemented these and thirdly through the effect of their views of learning and teaching and their knowledge and confidence on their actions and interactions. The fourth and final way they influenced formative assessment was through the forms of feedback they favoured. The influence of teacher institutionalised roles was discussed in Section 5.4.2. This section focuses on the unique contributions each teacher and student made to how formative assessment was accomplished.

Teacher implementation of tasks shaped formative assessment

One way the teachers were actors in formative assessment was the way they implemented assessment tasks and learning activities. Different teachers implemented the same activities in different ways and this provided different opportunities for formative interactions. The aspects of teacher implementation that influenced formative assessment were: (i) the integration of teaching and learning and formative assessment, (ii) the convergence of teacher formative assessment and (iii) the strength of the boundary constructed and maintained between school science and teacher and student everyday interests and knowledge. The first factor influenced the interactional or social context for formative assessment. The second two influenced what was taken-as-science and hence what it was appropriate for a student to disclose as school science. While these factors overlapped and were interdependent, they are discussed separately because of their impact on how school science and students as assessors and learners of science were constructed in particular classrooms.

The teachers assessed the students as an activity integral to and separate from teaching and learning. The degree to which a teacher integrated his or her

assessment with teaching and learning appeared to derive from a complex meld of the timing of the assessment and teacher purpose, planning and preference. For example, the teachers implemented planned assessment tasks at the beginning (Teachers 4, 5, 6, 7) and during (Teachers 1, 5, 9) the observed units so they served as learning activities. Three teachers implemented summative assessment tasks towards the end of a unit as learning activities (Teachers 5, 7, 8). By way of contrast, Teacher 2 required his students to peer, self and teacher assess at the end of each lesson as an activity separate from the learning activities.

When formative assessment by the teacher occurred as separate from the main teaching and learning activities in a lesson, it was a visible part of classroom life. This construed formative assessment as an activity teachers do while simultaneously constructing them as having power over knowledge and students. Case study 4 illustrated that this may happen even when teachers incorporate and legitimise a range of student responses. This is of concern when student involvement in formative assessment is seen as essential. Alternatively, when teacher assessment was integrated into teaching it was essentially rendered invisible. This was illustrated by the responses of the students in Cameo 10. They did not identify the activities they engaged in as assessment tasks. Student awareness of teacher assessment is of interest because of the students' claim that their perceptions of why they were being assessed influenced their willingness to disclose their ideas (Section 5.4.1).

The convergence of teacher formative assessment was the second way teacher implementation of activities affected students' assessment opportunities (Torrance & Pryor, 1995). Convergent teacher assessment is that which focuses on what the teacher intends a student to learn. The ten teachers' convergent assessment was usually planned for and involved the use of pre-determined science referenced criteria to judge and respond to student ideas. An example was Teacher 3's use of quick questions at the beginning of each lesson. In contrast, divergent teacher assessment was responsive to what the students knew, understood or could do. This assessment took place when the students were engaged in learning activities and the teachers often used emergent criteria to make sense of and respond to student ideas and actions. An example was Teacher 5 responding to students'

ideas about the effect of heat on solids (Cameo 4) and Teacher 7 acting to help students appreciate the properties of oil and water as part of the process of separating the two substances (Cameo 13). The significance of the convergence of teacher assessment was that it shaped what it was meaningful for students to disclose and hence what counted as valued school science.

The final way that teacher implementation of activities influenced formative assessment, was through the way they framed school science. Frame refers to the boundary the teachers constructed and maintained between school science and their own and their students' interests, knowledge and experiences (Section 2.2.3). The nature of the frame which the teachers maintained shaped what counted as school science and influenced what the students might disclose as valued school science. For instance, Teacher 5 maintained a strong link between scientific knowledge and students' experiences by encouraging students to bring in artefacts from home and to contribute the connections they were making with their everyday experiences. Cameos 2 and 4 illustrated how she utilised this connection to encourage her students to contribute their experiences when they were confused as to the composition of soil and the effect of heat and cold on solids. Student-referenced feedback both strengthened and relied on a link between student experiences and science. Teacher 8 used her knowledge of student interests to encourage one student to link the observation skills needed to be a model (of fashion) with those of scientific observation. Teacher 7 drew on a students' interest in rugby to help him consider the idea of a gas (T7/FN6/96) and Teacher 9 made a link between running a race and the notion of a fair test (T9/FN4/96). When the teachers maintained a weaker link between students' experiences and science they tended to provide feedback which placed more emphasis on the authority of texts and their own scientific explanations (Case study 4).

To summarise, teacher implementation of tasks shaped student assessment opportunities because this influenced whether formative assessment was constituted as an activity teachers or students engaged in and how school science was constituted in a particular classroom.

Teacher knowledge mediated formative assessment

Another way the teachers were actors in formative assessment was that their knowledge and experience mediated their formative assessment actions. They considered their knowledge of “how to teach”, their skills in “handling” students and “facilitating learning”, circumscribed their assessment actions (TD9/96/26.28-26.41; TD10/96/28.43). More specifically, they claimed their knowledge of and experience in using an assessment strategy influenced their ability to use the strategy responsively (Case study 6). They considered that their content and pedagogical content knowledge influenced their assessment actions and interactions. It allowed them to filter out the irrelevant information. One teacher explained:

Gathering information is not as simple as that .. we need a filter ...you gather information but then you interpret what you want to do with it, and you have to filter which is relevant, which is not (TD7/96/20.36; TD7/96/20.37)

The role of the teacher's knowledge of science was noted:

Yes, well you see that's the whole notion about whether you need to have some science yourself to teach it. ... I would say you do. I mean, you don't have to have heaps of it, but you have to have some to be able to interact with the students. To be able to recognise and respond, you have to have some scientific knowledge in order to respond to it. Otherwise, you're just talking around on ill-formed ideas and we have a responsibility in teaching ... [to teach] ... the scientific ideas. That's not saying that all students are going to learn it and that's the only goal of the lesson, but the government and parents charge you with responsibility of teaching science (TD10/96/28.6).

The teachers considered their professional knowledge allowed them to “take advantage of the one-off situations that sometimes happen” (TD9/96/26.41). Their experience of teaching a particular concept was considered to be pivotal to their recognising the significance of student actions and comments and in interpreting them as idiosyncratic or widely held alternative conceptions. They claimed this knowledge was critical in their being able to take appropriate actions.

For example, when Teacher 9 asked her students to separate the colour pigments in ink, she commented that if the purpose of the activity had been chromatography rather than scientific ways of investigating she would have interpreted the elicited information in a different way. The teachers commented that the importance of their professional knowledge was highlighted for them when they watched student teachers because they could recognise the implications of certain student comments and actions in terms of how they were thinking and what actions might help them reconsider their views.

Teacher affective characteristics mediated formative assessment

A further way teachers were actors in formative assessment, especially formative assessment through interaction, was that their actions were mediated by the affective factors of tolerance for ambiguity and uncertainty and confidence. The teachers asserted responding to student ideas involved uncertainty and risk because the responses could not be completely preplanned. (TD9/96/46.30). Teacher tolerance of uncertainty appeared to influence their practice. For instance, Teacher 7 described her “relief” that her posing a question to elicit student views and stimulate a discussion about density had gone “nice and smoothly” (T7/D/96). She noted that students did not always want to “bother” discussing an idea and so the strategy was “risky”. On this occasion, she commented that it had provided her with intriguing insights into the connections students had made (Cameo 15). In contrast, Teacher 3 meticulously prepared and implemented a lesson on electric power by assessing the students’ understanding of each step of his prepared sequence. He noted his approach had been “fairly well set”. He did not appropriate and build on student ideas in the moment. This produced a situation which was much less ambiguous and uncertain for him but it was difficult to determine the sense the students were making of the activities (Cameo 6)

Teacher confidence in their ability to teach and in their understanding of the relevant subject knowledge also mediated their formative actions (TD9/96/26.41) as was illustrated in Cameo 4.

Teacher views of teaching, learning and assessing mediated assessment

The final way teachers were actors in formative assessment was that their formative assessment practices appeared to be generally consonant with their stated views of assessment. Two broad approaches were identified: assessment that focused on what was taught and assessment of the sense students were making. Teacher 3, for instance, emphasised the role of assessment in supporting teaching. In practice he used a range of planned formative assessment tasks to check if students had learned what he intended. In contrast, Teacher 5 described assessment as a strategy for helping her to find out student ideas for the purpose of building on and incorporating them into her unit. The second half of each lesson was planned, in part, as a “space” for her to do this. The distinction the students made between teachers checking on and finding out about their learning was consonant with these two broad teacher assessment purposes (Cameo 15).

Alongside this, the teachers assessed students to communicate their expectations. Teacher 2 devised an assessment system that included a written assessment guide and teacher, peer and self-assessment to do this (T2/I/95a; T2/FN1-7). Teacher 9 also had this assessment focus given the observations took place at the beginning of the year (Section 4.6.1). Teacher 8 emphasised the role of assessment in support of student engagement, motivation and self-esteem. She assessed the students in an ongoing way and provided them with feedback that construed them as thoughtful and as having been actively engaged in the set task.

6.5.2 Students as actors in formative assessment

The students were also actors in formative assessment. Chapter 5 set out how their actions shaped teacher assessment and they acted to shape the assessment they experienced. Here, the ways in which students, together with teachers, were actors in formative assessment is discussed.

Students and teachers together were actors in formative assessment because their relationships mediated their formative assessment actions and interactions. When learning is viewed as a social practice, it is necessary to consider how interpersonal relationships effect the understandings that are developed, especially with respect to whether or not ideas have the opportunity to be expressed

(disclosed) and how they may be negotiated. The influence of the special nature of institutionalised teacher and student relationships was discussed in Section 6.4.3 as an aspect of the classroom plane. Formative assessment was also influenced by and contributed to the unique relationships that developed between teachers and students as individuals, groups and as a class as they affiliated over time.

According to the students, the aspects of interpersonal relationships that supported their participation in formative assessment were mutual trust and respect. They were more prepared to disclose their ideas to and seek help from trusted peers than teachers because they could be relied upon to act and react in ways that did not undermine their self esteem or relationships with others (section 5.4.6). Respectful teachers were those who treated students as though they were thoughtful. They did not imply a student was slow to understand, “pick on” or “shout” at students. The students’ view that respect was a reciprocal activity - students respected teachers who respected them - added strength to their claim that respect was an important influence on the effectiveness of the gathering and feedback aspects of teacher formative assessment.

Interpersonal relationships were also viewed as important by the teachers. The importance they placed on maintaining these relationships was evident in their care-referenced actions. They were careful to act in a manner which developed and sustained a trusting, supportive and respectful relationship between them and their students. Their actions were congruent with what Davidson (1990) defined as interpreting the actions of others by applying the “principle of charity”. Numerous instances of teachers applying the principle of charity were observed. These included the time when Teacher 9 responded to two students, who approached her to say they did not understand the idea of a control, (T9/FN4,D4/96) by reviewing her own actions. She concluded the students’ confusion had arisen from the disjointed nature of the preceding lessons rather than lack of effort on their part and re-explained the idea. The assumption of charity was evident in Teacher 7’s response to a student who wished to separate sand and salt using tweezers (T7/FN1/96) and in Teacher 5’s response to a student who suggested top soil was dark because it was sunburnt (T5/FN10/95b).

Formative assessment also contributed to relationships in the classrooms. It influenced how students came to view themselves and each other. For example, the students indicated they came to identify some of their peers as “bright” (section 5.2.2) and others important (section 5.7) through differences in how teachers assessed these students. They indicated that it was of concern to them that their questions, comments and action could lead to their being considered “stupid” or “dumb” or “try hards”. This led them to monitor and manage the questions they asked (section 5.4.3).

To summarise, teachers and students were actors in the activity called formative assessment. Interestingly, both groups identified the same factors as influencing their actions: their prior knowledge and experience and their confidence. Their interpersonal relationships mediated their interactions thus contributing to the formative assessment that emerged and was accomplished.

6.6 Formative assessment as a meaning making activity

The final dimension of formative assessment suggested by an analysis of the case studies, student views and teacher development day data was that it is a meaning making activity. Formative assessment was not only situated by the classroom, curriculum and interpersonal relationships it shaped what it meant to be a student (and a teacher), what counted and was valued as school science. It shaped what it meant to be a student and a learner of science in a particular classroom - what type of learning was valued, whose knowledge was valued and what counted as a legitimate scientific understanding. It shaped and contributed to interpersonal relationships and subsequently to students’ identities as learners; their feelings about themselves as learners and their status and relationships with others. This section describes these effects or meanings of formative assessment. The emphasis is on the student perspectives.

The students’ descriptions of the limitations and effects of assessment and of their own and teacher purposes for engaging in formative assessment indicated they experienced it as having relational, social, affective and cognitive effects or meanings. They highlighted the ways the teachers’ roles and responsibilities facilitated teacher formative assessment thereby construing themselves as

relatively powerless. Their concerns about being assessed as “dumb”, “slow” and “a try hard” suggested peer and teacher assessment influenced their feelings about themselves and their status and relationships with others thereby influencing their identities in the classroom. Student comments and actions suggested that in each classroom, teacher formative assessment communicated and contributed to the constitution of whether being a student of science was about completing tasks (Case study 3), remembering facts (Case study 4), developing personally meaningful explanations (Case study 1), reaching a consensus explanation of empirical evidence (Cameo 4) or understanding a particular scientific concept (Cameo 15).

The teachers’ descriptions of their assessment purposes and practices indicated they were aware of and often deliberately utilised formative assessment to shape the meanings that were made in their classrooms. Teacher 2’s planned assessment system was designed to communicate his expectations and to help students recognise what they knew (T2/I/95a). Teacher 9 deliberately reported back on student ideas at the end of a lesson (T9/FN2,3,4,5/96) to “link the students into my [her] agenda” that they “think deeply” (T9/EOY/96). Teacher 7 used a focus question to check and ensure the students understood the notion of density (Cameo 15).

The teachers described formative assessment as a meaning making activity they used for “encouraging and guiding ... giving directions and fine tuning” (TD5/96/15.60) and for “intervening in” and “steering” student learning towards scientific understandings (TD7/1996). One teacher explained their view thus:

... it's sort of as if we're a trouble shooter and just watching if things are moving in the right direction ... You have to intervene in some way. It could be to the whole group or an individual. (TD7/96/20.71)

Another teacher explained the guiding process thus:

So by asking questions, on a fairly informal basis, you find out that this kid is way off track and really not going to achieve the objectives that I had planned. So then

exploring alternative methods and backtrack, taking them back.

(TD5/96/15.15)

In another example, Teacher 6 described her formative assessment thus:

I wait to see where it's [student learning is] going to go, and if they're going to hit that [her learning purpose] ... then they're allowed to go and they can get there but otherwise I re-steer them back on to track. (T6/EOY/96)

It appeared the teachers viewed learning as a journey with a predetermined destination - that of their desired learning outcome - and formative assessment was a process they used to ensure the students reached this destination (developed the desired understandings). The teachers' description of the curriculum as a "map" with formative assessment at the beginning of and during a unit as locating where the students were "at" - what they knew and could do - in order to build on this and to check if students were "on the right track" was consonant with a view of learning as a journey. A possible explanation for the importance the teachers attributed to their experience (Section 6.5.1) was that their having already travelled the landscape of students' ideas meant they were able to notice and anticipate the consequences of particular student comments and questions. A view of learning as a journey with a specific destination was also evident in the teachers' view they were responsible for fostering "movement" or "progress" in student understanding from one "stage" or "level" to the next.

A plausible explanation for differences in teacher formative assessment is that the teachers tolerated more or less divergence in the pathways the students took or the meanings they made. The teachers described learning as non "linear" process and asserted their formative assessment needed to be "flexible" in order to respond to the many "pathways" of student learning. They explained:

it [formative assessment] develops as you go on ... depending on the pathways that have opened (TD4/95/11.28)

We mentioned flexibility .. there are different paths that people can take to achieve the same goal, and we talked about.. the fact that, to gain ...

maximum movement in learning ... there needs to be flexibility throughout your programme ... in order to take advantage of what .. you've found out (TD4/95/11.39)

Cameo 4 illustrated an occasion in which a teacher allowed divergent discussion, Cameos 10, 11 and 14 provided an examples of how a teacher might redefine her short term goals for student learning within the framework of her long term goals. Teacher 6 described this process thus:

You can usually tell from some of the discussion that you're getting as to whether or not that's heading in a direction that's going to have relevance to your unit, to your purpose, or to an objective. Not that specific objective, but an objective within that unit.

In contrast, Cameo 6 illustrated how one teacher maintained strict control over what ideas were legitimated and when. Moreover, it seemed that some teachers saw understanding as a long term goal and considered they were laying a basis for later learning (Case study 4) whereas others acted more than once to help students understand ideas in the short term (Case studies 2 and 5).

In practice, the teachers legitimated some student ideas and not others thereby contributing to what counted as school science (Cameo 2,3,15). They favoured different forms of feedback and this contributed to how school science was constituted in the classroom. The forms of feedback favoured by a teacher appeared to be linked to his or her view of teaching, learning and science. For example, Teacher 3 viewed assessment as informing his teaching, his assessment focus was on students having a complete record of and being able to recall the science he taught. His usual feedback actions were to legitimate a range of student ideas, to refer students to their notes and to demonstrate ideas, that is he used his own authority as a teacher and appealed to the authority of text and empirical evidence. In contrast, Teacher 5 focused on assessment to feed forward into what the students might learn next and to foster student self assessment. Her assessment feedback focused on students developing coherent explanation of empirical evidence.

While formative assessment communicated and contributed to the construction of meaning in the classroom meanings were not always shared. Confusion over meanings arose in oral questioning when students and teachers were using different frames of reference and could not appropriate each other's questions and answers (Cameo 7). Confusion over the meaning of teacher feedback arose when the teacher focused on longer term learning goals that were not immediately obvious to students (SG23/L4/96). Confusion over the meaning or purposes for engaging in activities appeared to lead students to ignore teacher feedback. When the students did not share their teacher's learning purpose they did not appropriate his or her feedback. All the teachers reported this happened when they asked the students to identify a masked can as diet or normal coke (Bell & Cowie, 1997). The students were concerned to do this so they could drink the coke rather than conduct a scientific enquiry. In another example, a student ignored his teacher's feedback that his flame tests were incorrect because he did not "care" about the results (SG82/L8/96).

To summarise, the teachers and students construed formative assessment as a meaning activity through their description of it as an intentional activity. The students' experience of formative assessment as a meaning making activity was evident in their descriptions of its effects. However, it appeared that that the meanings that were communicated and constructed through formative assessment were not always shared.

6.7 Formative assessment is a complex activity

From the data analysis, formative assessment can be viewed as a complex activity. Sumara and Davis (1997), drawing on complexity theory made a distinction between a complicated and a complex system. They quoted Waldrop (1992) in stating complex systems have three distinguishing characteristics. Firstly, complex systems have the capacity to undergo spontaneous self-organisation so that collective properties such as thought and purpose emerge in ways that might never have been manifested by any of the parts. Secondly, complex systems are adaptive in that the environment and the individual organism are mutually and simultaneously specifying. Thirdly, complex systems are different from complicated systems that can be understood by analysing their components. A

complex system, Davis argues, must be considered as a whole and attention given to the dynamic interactions and relationships between the parts and participants. A synthesis of the teacher and student views indicates that they perceived and experienced formative assessment as a situated, interactional, intentional, relational and interpretive activity. They indicated that to understand assessment it is necessary to consider their goals, their perception of the each other's purposes, their relationships and their perception of each other's likely actions and reactions. It seemed the complexity of assessment arose from the various, overlapping and sometimes emergent and conflicting situated purposes the students had for initiating and participating in formative assessment and from the differences in meanings they ascribed to each other's purposes, questions, responses and actions. Moreover, the students indicated the complexity of assessment also derived from the diversity, unpredictability and emergent nature and ongoing influence of the consequences or meanings that emerged and are made by formative assessment. The students asserted they experienced assessment as having cognitive, emotional and relational (social) meanings which variously enhanced their understanding, enhanced and harmed their relationships with their peers and the teacher, embarrassed them and undermined their self esteem. The students' claims suggested that in the classroom, where learning was the legitimated purpose of participation, learning was inextricably intertwined with who they are and who they are seen to be: learning and being were inseparable. A conceptualisation of learning and identity as inseparable and embedded in interaction has consequences for what might count as learning and valid assessment.

6.8 Summary

The most noticeable outcome of the analysis of the case studies, student views and the teacher development day data was the extent to which formative assessment was perceived and experienced as embedded in interaction and contextualised in and by the classrooms. Moreover, to understand formative assessment in a particular classroom, it was necessary to take into account the setting or scene, the teacher and students as active and intentional participants, and the meanings they jointly constructed. This suggested formative assessment maybe usefully viewed as a socio-cultural activity (Wertsch, 1991, 1998; Rogoff, 1995, 1998).

7. Summary and Discussion

7.1 Introduction

This chapter summarises and discusses the findings of the study, then considers their implications for the practice of formative assessment, teacher development and for what counts as a valid formative assessment. Specifically, Section 7.2 addresses the first research question about teacher and student perceptions, experiences and actions relating to formative assessment in the course of everyday classroom events. The findings indicate that formative assessment is a situated, social, meaning making activity in which teachers and students are active and intentional participants. With respect to the second research question, Section 7.3 argues that a sociocultural view of learning currently provides the most useful way of theorising how formative assessment is accomplished and experienced in science classrooms. Rogoff's (1995) multilayered model for describing and analysing sociocultural activities is adapted to elaborate on the nature of formative assessment. Section 7.4 discusses the implications of the methodology adopted in the study, Section 7.5 discusses the implications of the findings and finally, Section 7.6 discusses the implications for further research.

7.2 Teacher and student perceptions and experiences of formative assessment

The first research question, which is the focus of this section, was:

Was formative assessment being used and if so, what was the nature of this formative assessment and how was it perceived and experienced?

The classroom episode with which the thesis began provided an example of how formative assessment might be accomplished. In this episode, a student posed a question to the teacher to elicit feedback on the viability of his idea that filtering could separate oil and water. The teacher, recognising the implications of the student question, responded by providing the student, others in his group and then the whole class with empirical evidence to challenge his suggestion. She then

moved to elicit further information on student understanding of the properties of the substances that she was asking them to separate. One way to look at this episode in the study is to see it as a meaning-making event with actors, topics, intentions, relationships, settings, uncertainties and risks. Put another way, the data support the view that formative assessment is social, situated, meaning making activity in which teachers and students are active and intentional participants.

7.2.1 Formative assessment is a meaning making activity

The key characteristic of formative assessment explicated by the study is that it is, to paraphrase Broadfoot (1996a, p. 28), "arguably one of the most important vehicles for creating meaning through interaction". Formative assessment was made possible by, derived meaning from and contributed to, the meaning, of classroom activities, actions and interactions.

Attending to student perspectives and experiences highlighted the way formative assessment contributes to the mutual construction of what it means to be a student and a teacher. For instance, teacher assessment of students while standing behind them simultaneously constructed teachers as having the authority to require students to disclose their ideas and students as not having the authority to resist this action, although it was an action which students usually found unacceptable. Teacher feedback on student ideas was sought because teachers were perceived to be the final arbiter of what was right in the classroom. Formative assessment influenced student perceptions of the purpose of task engagement, although teachers and students did not necessarily share these meanings (Cameo 9). Student perceptions that teacher time and attention were limited and teachers assessed what was important to them meant that teacher assessment served to communicate to the students who and what was important to the teacher.

In the case study classrooms, formative assessment shaped how school science came to be constructed. Teacher actions and feedback framed what was taken-as-school science (in particular, how it was linked with students' everyday experiences) and determined what counted and was valued as legitimate school science (for example, what counted as a land form, what was an acceptable

definition of electric current, what was the correct way to draw a scientific diagram and what was the nature of a scientific control). By shaping the nature of school science, formative assessment also influenced what it meant to be a learner of school science in a particular classroom (Greeno, Collins & Resnick, 1996). A key distinction was whether school science (and the learning of it) was construed as a collection of facts to be remembered for test purposes (Case study 4) or as explanations that students could construct either personally or together (Case studies 1 and 2). Thus, the findings of the study extend Poole's (1994) contention that classroom testing shapes how knowledge is construed. In this study, ongoing teacher formative assessment also served this role. However it needs to be emphasised that not all students develop the same perceptions of the nature of school science nor of their role as learners.

For students, the key feature of formative assessment as a meaning making activity was that it contributed to their identity in the classroom (Bruner, 1996; Lave & Wenger, 1991). The students contended that disclosing their ideas in an attempt to enhance their understanding could lead their peers and the teacher to perceive them as "try hards", "bright" or "dumb" and to their learning being enhanced or them being embarrassed and feeling stupid. They indicated that for them assessment and learning were intimately connected and inherently linked with who they were and how they felt. Reay and Wiliam (1999) also found assessment contributes to students' identities. Black (1998) made a similar point when he contended: "A pupil's development as a learner is closely bound up with personal development as a whole." (p. 5). In the classroom, learning and the formative assessment of it affects students' identity as knowers and learners and also as a peer and a student.

7.2.2 Teachers and students are "actors" in formative assessment

The findings of the study support the view that students and teachers are actors in formative assessment. Their interests, prior experiences, knowledge, concerns and feelings mediate their formative assessment actions and interactions. They are active and intentional participants in the process. Teachers and students simultaneously create the setting for formative assessment, are part of the context for assessment, and participate in it.

Students as actors in formative assessment

The students were actors in formative assessment in three ways: their goals and interests mediated their interactions, they sought to manage the disclosure of their learning and they assessed the teacher. These are discussed in turn.

The first way the students were actors in formative assessment was that they assessed their circumstances and the goals they pursued influenced the nature of their participation. Specifically, they juggled and pursued academic (Dweck, 1986) and social goals (Juvonen & Wentzel, 1996) that formed interrelated experiences for them in a classroom context in which teacher and peer influences were unpredictable and could be contradictory. Moreover, the students indicated there was a relationship between academic achievement goals and the criteria used to assess ideas, the form of feedback preferred and who was viewed as responsible for assessment. Students with understanding as a goal indicated they assessed their ideas using the criteria of agreement with an authority (teacher, text and peer) as well as coherence and consistency with empirical evidence. These criteria are similar to those described by Driver, Leach, Millar and Scott (1996) and the warrants of viability identified by Ritchie, Tobin & Hook (1997). The nature of the criteria indicate that while the students sought to make sense of the science the authority attributed to teachers also influenced student self-assessment. In addition, students with learning goals indicated they preferred feedback in the form of suggestions because they were able to build on these thereby indicating that they sought to make sense of ideas. Alongside this, students with learning goals viewed assessment as a joint teacher-student responsibility. In contrast, students with performance goals indicated they preferred feedback to help them complete tasks. They asserted assessment was a teacher responsibility. Thus, the findings of the study have parallels with the work of Butler and Neuman (1995). They also found that student goals influenced willingness to seek help, as an outcome of a self-assessment.

Students as actors shaped formative assessment through the effect of their prior experience of and interest in the science being studied. Individuals not only participated in different formative assessment interactions with the teacher during the same lesson (Cameo 8), they also perceived the same interaction in different

ways (Cameo 14). Thus, the findings of the study support Perrenoud's (1998) contention that it is a delicate matter to generalise the nature of formative assessment across classrooms. The data indicate it would be unwise to generalise from any one student's experience.

The students had strong views about interactions that they considered could disclose what they knew and could do. Disclosing their ideas was said to have emotional and social as well as cognitive effects (Erickson & Shultz, 1992) which could be beneficial but which could also be harmful. The students appreciated the times when their teachers sought to find out about their ideas for the purpose of helping them but they were concerned about participating in interactions in which teachers might be "checking" on them, particularly in a whole class situation.

The students reported they managed the disclosure of their ideas by choosing (and not choosing) to ask questions and by acting to restrict teachers' incidental access to their bookwork. Moreover, their experience of teacher reactions was said to lead them to act in ways that suggested they were paying attention and/or understanding even when they were not. They also deliberately asked "what-if" questions that apparently disclosed their ideas but were really intended to manage their circumstances, both to help them "get by" (Perrenoud, 1991) and to enhance their status with the teacher. Thus understood, students disclosing what they could and could not do and understand was both a deliberate and dilemma driven action and so, as was proposed by Wiliam (1992), assessment tasks and interactions do not necessarily provide robust information about what students know, think, feel and can do.

Students were also actors in formative assessment in that they actively assessed their teachers. They had learnt from experience that teachers reacted to their questions in a range of ways and so the students were concerned to know how their classroom teacher was likely to react to any particular question they asked. Students were able to state what their teacher considered important indicating that they assessed this. Such assessment would seem to be crucial if students are to distinguish what is important in the classroom (at least to the teacher and hence their learning) from all that is happening (Barnes, 1976).

The students were also actors together in formative assessment. Students sought help from their peers. Peer feedback was reported to be more useful than that of teachers because peers had similar experiences to draw on and used language the student understood. Despite this, student actions indicated teachers were viewed as the final arbiter on what was taken as a legitimate scientific explanation and so interaction with them was also considered important.

Taken together, student comments and actions indicated they were active, thinking, caring and intending rather than passive participants in formative interactions. Thus in the context of formative assessment in science lessons for Years 7 to 10 students, the findings of the study confirm the claim by Reay and Wiliam (1999) that "children are simultaneously active in the assessment process and are profoundly affected by it" (p. 345).

Teachers as actors in formative assessment

The teachers were also actors in the process of formative assessment. They initiated and participated in assessment interactions for a variety of purposes. Their preferred forms of assessment and feedback along with their confidence and knowledge influenced the nature of the assessment that was accomplished in the classroom.

The teachers reported that their formative assessment was purpose driven. They planned to elicit information on student learning for the purpose of promoting individual student and class coverage of curriculum science. In contrast, their formative assessment through interaction (interactive formative assessment) focused on what students understood for the purpose of responding to this. The teachers stated they switched between the two forms and purposes of formative assessment as they sought to juggle and meet their responsibilities for class understanding and coverage of the curriculum and for the learning of individual students. They also conflated assessment for summative and social management purposes with assessment for formative purposes in the way reported by Tunstall and Gipps (1995). It seemed teacher assessment was a dilemma driven action (Lampert, 1986) because it lay at the point of confluence of teacher responsibilities (Drummond, 1993).

The teachers also viewed their assessment of student task engagement and task completion as having a formative function because they had chosen the tasks to mediate student understanding or skills towards those of scientists. However, Case study 3 provided support for Perrenoud's (1991) proposal that confusion between activity and learning can undermine teacher formative assessment. A focus on task completion without an attendant focus on the meaning of the activity could lead students to conclude that the purpose of task completion was to keep them busy or for them to have fun.

The teachers were actors in formative assessment through the form of formative assessment they favoured. In some classrooms, assessment was accomplished as a teacher managed activity separate from teaching and learning. In others it was essentially invisible because it was integrated into the teaching and learning. Alongside this, the students in the study identified the social organisation of tasks as a critical influence on disclosure, a point also made by Erickson and Shultz (1992).

The teachers also shaped student formative assessment experiences through the forms of feedback they favoured. These forms included the use of empirical evidence, models and analogies, suggestions for students to consider, discussion, and the use of authority (their own or a text) to legitimate answers. These forms of feedback construed students as learners of school science (and indeed school science itself) in different ways. For instance, the provision of suggestions for student consideration was said by the students to keep the students thinking, thereby simultaneously communicating a teacher's respect for the student and construing school science as a process of developing coherent explanations. In contrast, the extensive use of convergent assessment and teacher authority construed school science as discrete, fixed facts and students as rememberers and forgetters (Lampert, 1986). Some students reported that this made them feel like robots.

Teacher assessment practices were generally consistent with their stated view of teaching learning and assessment thereby indicating that their views mediated their practices. For example, one teacher described formative assessment as a process he used to modify his teaching. He used a sequence of planned assessment

tasks to elicit his students' understanding of what he had taught and responded by re-explaining ideas, referring students to their notes and planning between lessons (Case study 4). Another teacher described assessment as an activity that allowed her to respond to student ideas and students to monitor their own learning. She encouraged students to share their ideas, to make links with their everyday experiences and to develop consensus explanations (Case study 2). Yet another teacher emphasised the role of formative assessment in supporting student task engagement, motivation and self-efficacy. She provided feedback for these purposes but the students were sometimes unsure as to the learning purpose for tasks and task engagement (Case study 3). Others have also found that teacher beliefs inform their practice (see, for example, Gipps, Brown, McCallum and McAlister, 1995 and Johnston, Guice, Baker, Malone & Michelson, 1995).

In the study, the teachers' "uncertainty orientation" has been found to influence teacher assessment practices. Huber and Roth (1990) defined uncertainty orientation in terms of tolerance for ambiguity and uncertainty. They also contended that teachers' orientations to uncertainty influenced the teachers' opportunities to learn about student ideas and to help students reflect on the appropriateness of their approaches. Uncertainty orientations seem to be important, given that the teachers considered interactive formative assessment to involve uncertainties and risks (Bell & Cowie, 1997). Teacher confidence in their knowledge of subject matter, pedagogical content knowledge and pedagogical skills were also identified by the teachers as crucial in their acting to respond to student comments and actions. Allinder (1995), working with special education teachers, also found that teachers with a strong belief in their personal and teaching efficacy made better use of formative assessment.

Students and teachers are mutual actors in formative assessment

The findings of the study also support the view that students and teachers are mutual actors in formative assessment. Formative assessment was mediated by, and contributed to, the unique relationships that developed between teachers and students as individuals, groups and as a class. Mutual trust and respect were identified as the key factors mediating student willingness to disclose their ideas to teachers and peers. Like Stone (1993), this study confirms that interpersonal

relationships are important in formative assessment, especially when students are taking risks and working at the edges of their understandings.

To summarise, teachers and students are active, intentional and feeling participants in formative assessment. Thus, the findings of this study support the view that formative assessment, like learning, is a process in which it is not sensible to separate the emotional, conative and cognitive aspects (Salomon & Perkins, 1998). They also support the contention by Tittle (1994) that the views and beliefs of the interpreters and users of assessment information (here teachers and students) are an important dimension of any theory of educational assessment.

7.2.3 Formative assessment is a social process

The findings of the study support the view that formative assessment is a social process. It is embedded in a range of social practices that involve direct and indirect interaction between teachers and students.

Students and formative assessment as a social process

The students' view of formative assessment as a social process was clearly illustrated by their insistence that their teachers could only assess their learning through face-to-face interaction with them. Face-to-face interaction was considered to enhance the fidelity (William, 1992) of teacher formative assessment because students could negotiate the meaning of teacher questions and because students were more prepared to ask questions, thereby disclosing their views. Teachers were said to provide more useful feedback during one-to-one and small group interactions. Thus, the students' comments confirm, in the context of formative assessment in science classrooms, the contention by Lave and Wenger (1991) that access to more expert others is a crucial aspect of learning and the formative assessment of it.

Student comments and actions indicated that social interaction was an aspect of student self-assessment. The students said they compared their ideas with those of other students and the teacher during whole class discussions. They reported asking questions of friends, peers, teachers and parents was an action they took

when they needed help (Newman & Schwager, 1995). They also showed and discussed bookwork with the teacher and peers.

Teachers and formative assessment as a social process

Teacher formative assessment was accomplished through a range of social practices. For instance, the teachers generated information through the use of planned assessment tasks, "going around" while students were engaged in learning activities, looking at student books, switching between interaction and the use of planned tasks and switching between the use of individual and whole class strategies for eliciting information. The teachers provided formative feedback in the form of encouraging discussion (Cameo 4); asking students to reflect on the recorded purpose for doing an activity (Cameo 1); using models and analogies to persuade students to reconsider their ideas (Cameo 4); suggesting students test their ideas against empirical evidence (Cameo 12), and using their authority as teacher or the authority of texts to legitimate some explanations as scientific (Case study 4). In Chapter 6 these practices were described as aspects of two interrelated cyclical processes: planned formative assessment and interactive formative assessment.

Planned formative assessment involved the teachers using specific tasks to elicit information on student science understandings. The planned tasks usually generated information on the understandings of all students. They also served as a basis for teacher-student interactions. The planned formative assessment was generally consonant with convergent formative assessment as defined by Torrance and Pryor (1995). However, the teachers also (particularly the Year 7 and 8 teachers) planned to assess their students' personal and social development. Personal development was defined within the study as relating to students learning to learn skills and their constructing and reconstructing their own knowledge about what it means for each of them to be a learner of science. Student social development was defined within the study as relating to students learning to interact collaboratively with each other and the teacher to construct and reconstruct what it is to be a learner of science in the particular classroom and to promote the learning of science itself. The teachers' assessment of student social and personal development reflected their concern with the "whole person" and their view that the learning of science is deeply embedded in students'

personal and social development in their classrooms. It reflected their perception of their responsibilities as teachers for student learning as set out in the New Zealand Curriculum Framework (Ministry of Education, 1993a) which describes as valued learning outcomes skills that encompass aspects of the personal and social development of students. The teachers' assessment of students' social and personal development was consonant with and supported a view of learning and the formative assessment of it as a social activity.

The teachers also prepared, rather than specifically planned, to assess their students by interacting with the students while they were engaged in learning activities. The teachers prepared for the opportunity to assess and respond to their students by using their experience and knowledge to anticipate what sense the students might make of the activities they were using and to be able to appreciate and respond to the actions they observed. In the end, however, the interactive formative assessment depended on their noticing and recognising the implications of student actions and interactions. The teachers described this form of formative assessment as demanding and difficult but essential to responsive teaching (Bell & Cowie, 1997).

Teacher assessment through interaction focused on students' personal, social and science development. The teachers' science focus tended to be on the ideas students were developing rather than simply whether they understood the curriculum science, although teachers' knowledge of this obviously informed their interactive assessment. Hence, the teachers' interactive formative assessment was generally consonant with the divergent formative assessment described by Torrance and Pryor (1995).

The interpretations the teachers made and the actions they took were science and student referenced (Crooks, 1988); that is they acted to mediate student ideas towards those of scientists using their knowledge of science and of the students. The sources of persuasion they used in their feedback actions were similar to those the students reported they used to assess their ideas. That is, the teachers appealed to empirical evidence (albeit sometimes recalled rather than actual), the coherence of ideas, consensus and their own authority and the authority of texts to persuade students to reconsider their position. The teachers in the study also acted

in care-referenced ways (Noddings, 1995) to maintain and enhance the students' relationships with science, each other and with themselves as teachers in the belief this sustained student motivation and conation and therefore supported student learning. This teacher action is consonant with a view of learning as a social and relational activity (Lave, 1988).

Taken together, teacher and student comments and actions construed formative assessment as a social process that was accomplished through direct and indirect interactions.

7.2.4 Formative assessment is a situated process

The findings of the study support the view that formative assessment is a situated activity. That is, formative assessment is shaped by and shapes the social interactional, cultural, institutional and historical context (Wertsch, 1991, p. 86). The aspects of the setting that were identified in this study as shaping teacher and student formative assessment opportunities and actions were the community, the institution or school, the classroom, the curriculum and the temporal context. The community plane highlighted the influence of the reporting and accountability functions of classroom assessment. The institutional or school setting foregrounded the influence of the organisation of schools, the physical setting and the school reporting procedures on teacher and student actions, interactions and relationships, and hence on their formative assessment opportunities. The classroom plane foregrounded how teacher and student formative assessment opportunities and experiences were shaped by the nature of teacher and student rights and responsibilities. In particular, the taken-for-granted rights of the teachers to require students to disclose their ideas facilitated their access to student learning. The teachers' institutionalised responsibility for student learning gave their actions a situated significance. The curriculum plane foregrounded the nature of what the teachers assessed as valued learning (the development of students' personal, social and science knowledge and skills) and how the learning activities and assessment tasks they selected shaped teacher and student formative assessment opportunities. The temporal plane foregrounded the influence of the continuity in teacher - student relationships and the mutual expectations and understandings that developed and then informed and enriched (mediated) their interactions and the interactions they anticipated (Rogoff, 1995). Formative

assessment was also situated in the temporal plane through student and teacher perceptions of school science. Both groups expected science lessons to include practical work, considered it enhanced student understanding of scientific ideas and consequently saw it as a useful focus for feedback. Thus understood, formative assessment was accomplished in different ways in different classrooms and so was situated by way of being distributed (Greeno, 1997; Salomon, 1993) over time, tasks, topics and relationships.

To summarise the answer to question 1, students and teachers initiated and actively participated in formative assessment actions and interactions that were situated by and contributed to the nature of the classroom as a social, intellectual and emotional setting for learning and the formative assessment of it. Formative assessment was a meaning making activity.

7.3 The nature of formative assessment as a sociocultural activity

The finding that formative assessment is a social, situated meaning making activity in which teachers and students are active, intentional and feeling participants provides the basis for the answer to the second research question: What theorising can be used to describe and explain formative assessment?

In this study it has been argued and supported by the data analysis that formative assessment is a sociocultural activity (Wertsch, 1991) that requires a multi-layered description and analysis (Hicks, 1996; Lave & Wenger, 1991). Conceptualising formative assessment as a sociocultural activity in which action occurs simultaneously along three planes (community, interpersonal and personal) as described by Rogoff (1995) and proposed earlier (Section 2.3), provides a structure for discussing how it was perceived and experienced by the teachers and students as part of their routine interactions. In this section, formative assessment processes and meanings are described along the community, interpersonal and personal planes, and then the notion of teachers and students privileging (Wertsch, 1991) different planes is used to discuss teacher and student assessment purposes.

7.3.1 The community plane

The findings indicate that on the community plane of description and analysis, formative assessment functions to apprentice children into the role of "student". Rogoff described apprenticeship as "involving active individuals participating in culturally organised activity that has as part of its purpose the development of mature participation in the activity by the less experienced people" (Rogoff, 1995, p. 142). She asserted that the notion of apprenticeship allows for the fact that endeavours involve purposes (defined in institutional terms), cultural constraints, resources, values relating to what means are appropriate for reaching goals, and cultural tools such as linguistic systems. Apprenticeship is a suitable way of conceptualising formative assessment at the community plane of focus because the actions the students described as formative assessment were embedded in taken-for-granted classroom practices. Formative assessment implicitly communicated and constructed what it meant to be a student (and a teacher). For example, the teachers' judging of student work without explaining their criteria continually constructed and reconstructed the teacher as having the ultimate authority over what counted as acceptable work. The students indicated that their apprenticeship into the role of student was supported by stories about situations involving their assessment. For instance, they related stories told to them by siblings and parents about how to act (and not act). Their descriptions of possible teacher reactions to questions were remarkably similar. Lave and Wenger (1991, p. 108), also identified the telling of stories about problematic situations as an aspect of apprenticeship (See also Measor & Wood, 1984).

7.3.2 The interpersonal plane

On the interpersonal plane, formative assessment was made up of face-to-face and indirect interactions as teachers and students engaged with each other and with activities and materials as they sought to manage their own and each other's roles and to structure the situations in which they participated. Commensurate with Rogoff's (1995) description of this plane, teacher and student participation in formative assessment involved the communication and co-ordination of aspects of the meanings of a shared endeavour, although the meanings themselves were not necessarily shared. On this plane, it appeared the teachers and students perceived and experienced formative assessment as a process of guided participation. The teachers described formative assessment as a process for guiding student learning

and helping them make "progress" to move along a pathway and up a level. The students also used the metaphor of learning as movement; teacher formative assessment informed them if they were "on track". As was also reported by Tasker and Freyberg (1985), the findings of this study indicate there were times when there was a mismatch between teacher and student views of the purposes of or meanings for activities and so the students didn't necessarily appreciate the relevance of teacher feedback. The findings indicate teacher formative assessment serves to reduce this mismatch (Cameo 5).

At the level of a particular classroom, formative assessment interactions served to guide and shape what became privileged ways of thinking, acting and speaking, thereby contributing to the creation and maintenance of what it meant to be a student and learner and what was taken and valued as school science in a specific classroom. The purposes of task engagement, what it was important to learn, who was important to the teacher, how students were perceived by others (dumb, slow or bright) and how they felt about themselves were shaped and to a some extent contested through formative assessment. Thus understood, formative assessment was the process through which teachers and students negotiated what counted as knowledge in the classroom, who could have knowledge, and how knowledge was generated, challenged and evaluated. Broadfoot, Pollard, Osborn, McNess and Triggs (1998), reporting on the impact of new assessment policies in England, also found that assessment shaped not only what it meant to be a student and a teacher but also the nature of relationships between teachers and students. Formative assessment therefore can have a significant impact on the student and teacher actors involved.

On the interpersonal plane, the language, in the sense of speech genres (Wertsch, 1991), used by teachers and peers was important. Since peers used a language shared by the students in the class this factor contributed to the usefulness of help from peers. Teachers who used language students could understand were considered to be concerned with student learning and to provide more useful help. On the other hand, when teachers and students were using different speech genres they were unable to appropriate each other's questions and /or answers (Cameo 6). Alongside this, students who used the speech genre of school science were construed as understanding ideas, even when they did not, and this influenced

what other students disclosed in whole class situations (Section 5.4).

Dialogic feedback, which kept students thinking, communicated the teacher's respect for their ideas. Students who had understanding as a goal preferred this kind of formative feedback.

7.3.3 The personal plane

On the personal plane, Rogoff (1995) used the notion of participatory appropriation to explain how individuals change through their involvement in an activity. The students indicated that their actions and interactions reflected their perceptions of the past and of the future they anticipated. It appeared that they assessed their actions and understandings for possible benefit and potential harm. They sought to juggle learning, social and affective goals. Only sometimes were their goals related to understanding scientific phenomena as a scientist might.

On this plane, the teachers and students described student learning in terms of students building on and acquiring knowledge in a manner more consonant with cognitive constructivist views of conceptual development. To a large extent, the students' claims that they used coherence, and consistency with empirical evidence, as means to evaluate their ideas is consonant with a view of formative self assessment from this perspective. However, it is difficult to know whether teachers and students spoke of learning in terms of the acquisition of knowledge simply because of the prevalence of this metaphor (Sfard, 1998) and their lack of access to possible alternative metaphors. The Year 7 and 8 teachers emphasised the benefits to student learning of sharing and discussing ideas. The students were emphatic about the benefits to their learning of interaction with others, particularly friends and trusted teachers. This suggests that they too viewed learning as socially mediated.

7.3.4 Privileging

Conceptualising formative assessment as a sociocultural activity in which action occurs simultaneously along the three planes (community, interpersonal and personal) provides a structure for discussing the multiple and often conflated and conflicting purposes the teachers and students identified for their participation in

classroom assessment interactions. Wertsch (1991) used the notion of privileging to describe the psychological aspects of judging which social language and speech genres were more appropriate than others in a particular sociocultural setting (p. 135). In the case of teacher and student assessment concerns and actions, the notion of privileging provides a useful way of explaining how the teachers and the students in the study managed and juggled their different purposes for assessment within the sociocultural context of the classroom.

Students and privileging

The purposes the students gave for seeking help, and the concerns they expressed about participating in assessment interactions, might be viewed as privileging different planes in the sociocultural activities they construed as assessment. Purposes concerned with learning and protecting oneself from harm are consonant with those discussed by Pryor and Torrance (1995) and may be viewed as privileging issues on the personal plane. Purposes to do with maintaining and enhancing relationships with peers and the teacher might be construed as privileging concerns on the interpersonal plane. In the sociocultural setting provided by the classroom a concern with learning is also an issue on the interpersonal plane. As noted previously, student comments suggested that for them assessment and learning are intimately connected and inherently linked with their identity within the classroom community, that is, with who they are and how they are seen by others. However, the significance to the students of their role as a student rather than that as a learner per se supports the contention by Lave and Wenger (1991, p. 112) that there are differences between learning in natural settings and learning in didactic situations. Any view of learning and the formative assessment of it needs to consider the influence of the classroom.

Teachers and privileging

Teacher assessment purposes may also be seen as privileging different planes. Teacher assessment for reporting, accountability, social control and to inform teaching privileges needs on the community plane. The wider community, as represented by educational agencies such as ERO, the Ministry of Education, parents, Boards of Trustees and the school, expect teachers to teach what is in the curriculum, to be able to demonstrate and report on student learning and to manage the classroom environment so that students are safe (Cowie & Bell,

1995a). The teachers privileging of this plane may be seen as an indication that, as Lemke (1990) contended, teachers do not have the final authority in the classroom. Teacher assessment to inform their teaching and hence student learning, and to maintain and enhance their relationships with students and students relations with each other (that is their care-referenced actions), may be seen to privilege issues associated with the interpersonal plane. A teacher assessment focus on enhancing students' social skills may be seen to privilege aspects of activity and learning associated with the interpersonal plane for the student. Teacher assessment actions that function to reduce the personal risks and uncertainties that students experience during and as a result of formative assessment, privilege issues to do with the personal plane. A teacher assessment focus on maintaining student relationships with science, enhancing student motivation and students' perceptions of themselves as sense makers (active learners) may also be seen to privilege aspects of activity and learning associated with the personal plane for the student. However, as Rogoff (1995) pointed out, it is impossible to consider issues associated with one plane in isolation from the other. For instance, privileging relationships can be viewed as (a) serving a social management function, (b) fostering a setting in which social learning was possible and (c) managing the affective aspects of the situation experienced by the teacher and students. Seen this way, the data indicate that formative assessment was a dilemma-driven activity (Lampert, 1986) because teachers and students juggled their desire and need to privilege the needs of those who were influential and influenced by the different planes.

This conceptualisation of teachers privileging different planes in sociocultural activity is related to the notion that assessments have different audiences (Carr & Cowie, 1997). It also links with the argument by Broadfoot (1998) that teacher assessment practices reflect their position in and response to current discourses about assessment. Further, it indicates clearly that the sociocultural setting shapes but does not determine teacher and student participation in formative assessment. Both teacher and student actions and interactions are also influenced by interpersonal and personal factors, so they retain some agency themselves. The formative assessment that is accomplished in the classroom is therefore diverse and varied.

To summarise, the findings of the study support the view that formative assessment may be described and analysed as a sociocultural activity along the planes of community, interpersonal and personal processes and meanings. Teachers and students perceived and experienced it as a complex and dilemma-driven activity because they each privileged different planes as they juggled the demands of their roles, relationships and goals in the social, intellectual, relationship and emotional milieu of the classroom.

7.4 Implications of the adopted methodology

Any research approach foregrounds certain features but in doing so backgrounds others. The researcher generates and tells only one of the many "stories" that might be told (Scheurich, 1996). This section discusses the implications of adopting a sociocultural framework and an interpretative methodology.

Sociocultural views of learning mean that a study takes place in a particular social, cultural, cognitive and temporal setting and involves the transformation of participation and development of voice. They emphasise the need for the research approach to be situationally appropriate. The effects of the tools (language and technologies) used and purposes and goals of all the participants on their actions (including the framing of the study, data generation, interpretation and representation) are highlighted. The methodologies appropriate for studying classroom learning and its formative assessment from this perspective are in a state of flux (Hicks, 1996, Rogoff, 1998). The unit of analysis is critical: multi-layered forms of interpretative analysis are needed (Hicks, 1996; Rogoff, 1995; Moll & Dworin, 1996; Pollard & Filer, 1996).

Determining the units for data generation, analysis and reporting on formative assessment in the classrooms was one of the most difficult and important decisions made during this study. Initially the unit for data generation, set out in the Learning in Science Project (Assessment) contract with the funding agency, was that of teacher formative assessment in a series of discrete lessons. Almost immediately, however, it became apparent that it was necessary for the researcher to have some understanding of the context of each classroom, what had gone before (in both learning and relationships) and what was intended, in order to fully

observe formative assessment in the classroom. The decision was made that the researcher would stay with each class while they worked through a complete unit and, when possible, interview the teacher and some students after each lesson (Cowie & Bell, 1995a). The changes represented a shift from a focus on rational individuals, to a focus on people in interaction and relations with each other in a particular setting. Put another way, this represented a shift from a unit of analysis appropriate when learning and the formative assessment of it is viewed as cognitive construction to a unit in which learning is viewed as a social activity.

Rogoff's (1995) approach of viewing activity as a sociocultural process with three broad planes of focus provided a way to simultaneously maintain a focus on the classroom, on teacher-student interactions and on individual actions, goals and perceptions. Appreciating the significance and meaning of and variation in teacher and student actions and interactions required consideration and understanding of the institutional, social, physical and temporal setting (Werstch, 1991). The emergence of this unit of analysis is in itself indicative of the sociocultural nature of learning and formative assessment in the observed classrooms.

The adopted methodology explicated the nature of the relationships between the setting and human action (and mental functioning) at the level of the situated experiences of individual teachers and some of their students. It provided for a focus on the socially constructed nature of both school science and students as learners of that science. The results served to highlight the diversity of student perceptions and experiences of formative assessment. However, neither the data generation methods (interviews, and participant observation recorded through field notes) nor the time frame of the study allowed for an in-depth analysis of how individual participation in science activities changed over time, particularly with respect to the influences of students' appropriation and /or construction of specific concepts such as density.

7.5 Implications of the study

The need to clarify the goals of (science) education is a key issue raised by the findings of this study. The present interest in formative assessment reflects a political change in focus from providing educational opportunities for all students

to promoting educational achievement for all students (Darling-Hammond, 1994; Gipps, 1994). It is perhaps an indication of a concern for individual success and empowerment as well as collective productivity (Dassa, Vazquez-Abad & Ajar, 1993). Formative assessment defined as assessment to help students bridge the gap between their current levels of performance and some desired level of performance begs the question of what kinds of performance are desired.

In New Zealand, the official answer to this question is set out in a number of policy documents that indicate that a main goal of education is the development of citizens who are life long learners (Ministry of Education, 1993a). Different views of learning are consonant with different goals in education (Case, 1996) but the development of students as life long learners appears to be consonant with a sociocultural view of learning (Brown, Ash, Rutherford, Nakagawa, Gordon & Campione, 1993). Greeno (1997) sums up in the form of a question, the possible goals for education. The question is framed in terms of a cognitive - situated dichotomy.

"Should we consider the major goals and outcomes of learning primarily as collections of sub skills or as successful participation in socially organised activity and the development of students' identities as learners?" (p. 9)

The diversity of ways in which students in the study were constructed, and constructed themselves, as learners of science indicates that formative assessment contributes to the process of students constructing themselves as learners of science, but not necessarily in the ways intended. Thus, the study supports the need to consider the effects of and interaction between ongoing formative assessment and teacher and student views and experiences at the level of the classroom. However, because teacher and student formative assessment practices are viewed as situated in the wider institutional, physical, historical and policy setting it poses a challenge to the wider community, schools, teachers and students as to how they might realise the potential of formative assessment to help students become a community of scholars (Brown, Ash, Rutherford, Nakagawa, Gordon & Campione, 1993).

The study has implications for in-service and pre-service teacher education and development. It is often claimed that teacher formative assessment practices are inadequate (Black & William, 1998; Daws & Singh, 1996; Bachor & Anderson, 1994) but the finding that formative assessment is a sociocultural activity raises questions about why and how teachers might change their practices given they are shaped (enabled and constrained) by the setting (the wider community, institution and classroom), informed by their view of teaching, learning and assessing, and constituted through interactions in which students are active participants. The response of the teachers in the study to the development of a model of formative assessment that acknowledges the tension between their various responsibilities (Bell & Cowie, 1997; Cowie & Bell, 1999) suggests that a sociocultural approach is useful for teachers; it values their current practice and may have the potential to help them explore changes.

The study also raises serious questions about the view of classrooms as places where the teacher is an expert and students novices. A more appropriate view would be one in which all are learning and changing, but in different ways: teachers are learners about children and how children know and come to know ideas, and students are learners about and participants in the practices of school science. If this alternative view is accepted then there are significant implications for curriculum. Teachers would need the freedom, flexibility, knowledge and skills to encourage students to explore their own ideas (about science) in ways that fostered the development of their skills and dispositions as life long learners (Carr, 1997) and as knowers about science, and which mediated their ideas towards those of scientists. Students would need opportunities to participate meaningfully in the processes of curriculum development (Pollard, Thiessen & Filer, 1997). They would also need to participate in assessment "as contributors to the formulation of standards and judgements of quality of work" (Greeno, Collins & Resnick, 1996, p. 39; Sadler, 1989). Given the mutually constituted nature of teacher and student roles and the relationship between learning and the social practices in which teachers and students participate, this form of student involvement may provide an opportunity for teachers and students to work together to enhance formative assessment.

Another issue suggested by the study is that teachers, researchers and students would benefit from a shared language for talking together about both learning as a sociocultural activity and formative assessment as an aspect of this activity. The teachers in the study debated the meaning of formative assessment throughout the study and only seemed to reach a consensus during the tenth teacher development day when they developed the "Bike" model of formative assessment. In this model the two types of formative assessment (planned and interactive) were linked through teacher purposes for formative assessment (Cowie & Bell, 1999). For the teachers, a key aspect of this model was that it acknowledged and helped them to become aware of the ways they assessed students during their everyday interactions. However, the dynamic nature of the interactions between their use of planned assessment tasks and of interaction to generate information and feedback currently poses challenges to current recommendations that formative assessment should be planned for. The findings suggest that "strong" formative assessment (Brown, 1996) also needs to be prepared for overtime. Teachers need to be aware of and be able to use a range of assessment strategies with knowledge of their limitations and advantages (Stiggins, 1991). They need an extensive knowledge of their own students and of research on student understanding in the area of study (Jones, Moreland & Northover, 1999). They may need help to appreciate the range of actions that communicate their expectations, what constitute valid, appropriate and valued ways to act, and what it means to learn and know. It seems that the presence of someone with whom they can reflect on a lesson is critical in this regard (Bell & Cowie, 1997).

The study raises significant questions about what might serve as valid formative assessment. The findings indicate that it does not make sense to evaluate the affective and social consequences of an assessment separately from its cognitive effects and meanings. The students and teachers perceived and experienced these as interrelated. Conceptualised this way, adequate and appropriate (valid) ways of generating interpreting and responding to information on students and their learning are those that benefit and not harm (Crooks, 1993) student learning, identity, feelings and relationships with others.

From a student perspective, it seems that valid formative assessment is trustworthy (Cowie & Bell, 1996; Guba & Lincoln, 1989). Student comments

indicate that the trustworthiness of an assessment derives from the processes used to generate and respond to information on student ideas and to student confidence in the people involved. Hargreaves (1994) described trust in a similar way as having two aspects: trust in the process and trust in persons. Technical issues to do with trust in the process have dominated debates on the nature of validity and reliability. In formative assessment that supports and does not undermine student understanding, affect and relationships, trustworthiness involves factors that impact on student access to opportunities to participate in formative assessment (Cowie & Bell, 1996). It involves factors that influence their willingness to participate in and respond to formative feedback. The fact that students see assessment as embedded in taken-for-granted interactions and activities suggests this will be pose challenges for teachers and students.

Student concerns about disclosure indicate the need for an ethics of classroom assessment similar to that for educational research (Erickson, 1998). The students identified confidentiality and the potential harm involved in disclosure as issues both within the classroom when the teacher's intention is formative, and also when the teacher summatively reports on student learning using informal assessment information. The teachers use of care-referenced actions indicates that an ethic of care (Gilligan, 1984) may provide a way of conceptualising the ethics of classroom assessment. An ethic of care highlights the relational nature of learning and supports a view of a classroom as a community but it also keeps in focus the importance of disciplinary knowledge.

The finding that formative assessment is a sociocultural activity challenges current conceptions of assessment as determining what students know as though knowledge is a possession which is transportable and may be called on to be displayed at will. It seems that student learning is distributed over people, tasks, tools and language (Greeno, 1997) so that student assessments include information about the teacher as well as the student (Filer, 1995). Hence, generalisations from year to year, or task to task, may not be valid. Seen this way, teachers' lack of trust in and use of the assessments of other teachers is not a weakness (Black & Wiliam, 1998), rather it may be viewed as a recognition of that assessment is both a social process and a social product (Filer, 1995).

However, this does pose questions about the meaning of assessment information to those outside the classroom.

In this study, the students provided a special insight into the nature and meanings of the classroom practice of formative assessment and also its links with summative assessment. The debate about the relationship between summative and formative assessment as outlined in Section 2.2.1 focused on differences in the roles and relationships involved, the technical issues of information gained, interpretations made and actions taken by the teacher. The students indicated that they were aware of the range in teacher assessment purposes. They were sensitive to nuances in teacher actions that signalled whether teachers were checking on and seeking to find out about their learning. Thus, student comments confirm the contention by Brown, Ash, Rutherford, Nakagawa, Gordon & Campione (1993) that when learning and the formative assessment of it take place within a community, such as exists over time in a classroom, the challenge for teachers is one of how to keep " the social contact with students... as co-equal participants in a community of sharing ... [while] maintaining their accountability for students' progress and to fellow scientists" (p. 217).

Student descriptions of the impact of even informal teacher assessment practices call into question the use of national or school-based testing as a strategy for enhancing learning. These teacher accountability driven forms of assessment take no cognisance of the likely negative impact on students' emotions, identity and relationships with teachers and peers (Jervis, 1991). Moreover, sociocultural views of learning construe these aspects as both mediating learning and part of what is learned, thereby increasing the salience of any negative impact when the promotion of student learning and the development of life long learners is the professed aim of education (Broadfoot, 1998; Ministry of Education, 1993a).

7.6 Implications for further research

The research described here has provided an insight into the perceptions and experiences of a small number of students and teachers during one unit of science. Given the differences in student and teacher perceptions and experiences of formative assessment within and across the case studies, it would be interesting to

study the effects and evolution of teacher and student formative assessment practices within individual classrooms over the course of a year and in a range of domains within science. This would allow for further explication of the nature of formative assessment as a sociocultural activity and of the relationship between formative assessment and the learning or transformation of participation of individual students and the classroom community of which they are a part. The importance the students attributed to language and to nuances in teacher and student actions suggests that further research would be supported by videotaping or by having some students and the teacher wear a microphone. This would generate more detailed data on ongoing student and teacher actions and interactions.

In the study, student perspectives were sought and provided a special insight into the nature of classroom formative assessment processes. Further research is needed into their experiences, particularly since researchers (see for example Bell & Gilbert, 1996) have found information about student views to be influential in stimulating teachers to reconsider their current practices. Given the willingness of the students in this study to participate in the research process, a productive avenue for further research would be to involve students as co-researchers. Tobin, Seiler and Walls (1999) worked with a student to gain insight into a student perspective. Walls also interviewed students about issues he and they considered important, thereby gaining access to data sources that were not otherwise readily accessible. The inclusion of students as co-researchers would provide further insights into formative assessment as it occurs as part of everyday classroom interactions.

To conclude, this research began by investigating teaching, learning and assessment and concluded by researching teachers, learners and assessors (where students and teachers acted as teachers, learners and assessor) in a specific but complex, dynamic environment. That is, it began by looking at processes and concluded by looking at people. It is clear that formative assessment is perceived and experienced by teachers and students as a complex, situated social, intentional, meaning-making activity. Thus understood, it may be theorised as a multilayered sociocultural activity that is intimately linked with being a teacher, a student, a learner and knower, and a peer in the classroom.

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