Using Formative Assessment Despite the Constraints of High Stakes Testing and Limited Resources: A Case Study of Chemistry Teachers in Anglophone Cameroon

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USING FORMATIVE ASSESSMENT DESPITE THE CONSTRAINTS OF HIGH STAKES TESTING AND LIMITED RESOURCES: A CASE STUDY OF CHEMISTRY TEACHERS IN ANGLOPHONE CAMEROON

by

George Viche Akom

A Dissertation
Submitted to the
Faculty of The Graduate College
in partial fulfillment of the
requirements for the
Degree of Doctor of Philosophy
The Mallinson Institute for Science Education
Advisor: Herb Fynnewever, Ph.D.

Western Michigan University
Kalamazoo, Michigan
June 2010
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George Viche Akom

ENTITLED  Using Formative Assessment Despite the Constraints of High Stakes Testing and Limited Resources: A Case Study of Chemistry Teachers in Anglophone Cameroon

AS PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE

DEGREE OF  Doctor of Philosophy

Mallinson Institute for Science Education

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Date  June 25, 2010
Formative assessment, as a strategy used to improve student learning, encounters several obstacles in its implementation. This study explores changes in teachers' views and practices as they are introduced to formative assessment in a high stakes testing and limited resource environment. The study examines the extent to which teachers use the technique of formative assessment to engage students in authentic learning even while not sacrificing high test scores on summative assessments.

A case study methodology was employed to address the research topic. Science teachers in the West African country of Cameroon were engaged in a process of lesson planning and implementation to collaboratively build lessons with large amounts of formative assessment. Qualitative data from written surveys, group discussions, classroom and workshop observations, and from teacher reflections reveal the extent to which lesson fidelity is preserved from views to planning to implementation.

The findings revealed that though the teachers possess knowledge of a variety of assessment methods they do not systematically use these methods to collect
information which could help in improving student learning. Oral questioning remained the dominant method of student assessment. The study also showed that the teachers made minimal to big changes depending on the particular aspect of formative assessment being considered. For aspects which needed just behavioral adaptations, the changes were significant but for those which needed acquisition of more pedagogic knowledge and skills the changes were minimal. In terms of constraints in the practice of formative assessment, the teachers cited large class size and lack of teaching materials as common ones. When provided with the opportunity to acquire teaching materials, however, they did not effectively utilize the opportunity. The study revealed a need for the acquisition of inquiry skills by the teachers which can serve as a platform for the implementation of formative assessment. Another implication of the findings is for teacher professional development to be on-going and classroom-based providing opportunities for teachers to experience and try new teaching methods.
ACKNOWLEDGMENTS

I would like to acknowledge the guidance and support, first and foremost, of my committee members: Dr. Herb Fynewever, who as the chair of the committee was relentless in his efforts in seeing me complete this project, Dr. Charles Henderson, and Dr. Marcia Fetters for their tons of valuable advice without which accomplishing this project would have been impossible.

I wish to thank the faculty, staff and students of the Mallinson Institute for Science Education, under the distinguished leadership of Dr. Bill Cobern, for all the help I received from them during my stay at the institute.

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Lastly, I would like to thank my entire family, especially my wife Comfort, for their constant support. I wish to thank them for enduring all sorts of hardship during my absence. I hope all of us will benefit from this rare opportunity that The Almighty has blessed me with.

George Viche Akom
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CHAPTER I

ABOUT THIS STUDY

Introduction

This chapter provides the background of the study. It presents an overview of the concept of formative assessment and its importance. The context of the study is outlined by presenting a brief history and geography of Cameroon, the general system of education in Anglophone Cameroon, and models of secondary teacher education in Cameroon. The chapter also discusses the research problem, states the main research questions as well as the significance of the study.

Background of the Study

Educational researchers (e.g. Angelo, 1990; Atkin, Black & Coffey, 2001; Harlen, 2003; Chappius, 2005; Leahy, Lyon, Thompson & Wiliam, 2005) generally agree that in order to promote learning, teachers and learners need to have an idea of what their goals are, where they are in the process of achieving these goals, and what strategies they can use to progress towards these goals. Knowing about students' existing ideas and skills, and recognizing the point where they are in development and the necessary steps to take (Harlen & James, 1997) constitutes what has been termed classroom assessment, formative assessment or assessment for learning. For the context of this study, the preferred term will be formative assessment though it may be used interchangeably with assessment for learning. Formative assessment is valuable in that it provides information on how students are progressing. This makes it possible for teachers to adjust their
teaching and also helps students realize where they are in terms of their desired goals and how to work towards them.

Many teachers, for a number of reasons discussed later, do not practice formative assessment. This results in many missed opportunities to enhance student learning. Educational researchers (e.g. Stiggins, 2002) have called for more investments in formative assessment in order to make assessment balanced. In Cameroon, with the presence of high stakes testing, limited teacher training, and teaching and learning resources, the situation may be further complicated. This study examines the changes and adaptations that chemistry teachers in Anglophone Cameroon, who are faced with such constraints, make as they introduced to the concept and practice of formative assessment. The study also looks at the difficulties and constraints that these teachers face in their practice of formative assessment with a view of guiding future efforts in teacher professional development.

What is Formative Assessment?

Formative assessment, when used appropriately, is incorporated into classroom instruction and aims at enhancing student learning. It stands in contrast to other types of assessments which are primarily used to assign grades or meet certain accountability demands of an external body. According to Angelo (1990), assessment for learning is a straightforward, learner-centered approach that uses assessment to improve teaching and learning in the classroom. Black and Wiliam (1998b) use the term formative assessment which they define as, "all those activities undertaken by teachers and their students [that] provide information to be used as feedback to modify the teaching and learning activities
in which they are engaged" (p. 7). Harlen (2003) refers to formative assessment as the "gathering and use of information about students' ongoing learning by both teachers and students to modify teaching and learning activities" (p. 7). From these definitions, and other formative assessment literature, key elements of formative assessment include:

- agreement by both teachers and students on learning goals, and criteria for achievement,
- active engagement of students in their own learning,
- provision of effective feedback to students,
- and adjusting teaching strategies to take account of identified learning needs and strengths (Black & Wiliam, 1998b; Steadman, 1998; Shepard, 2000; Stiggins, 1992; Marshall, 2005).

The value of formative assessment has been well documented. Research has shown that the use of formative assessment increases student achievement and closes the achievement gap amongst students (Black & Wiliam, 1998b; OECD, 2005; Marshall, 2005) more than other factors such as class-size reduction or increases in teachers' content knowledge, and at a fraction of the cost (Wiliam, 2007; Wiliam & Thompson, 2007). Black and Wiliam (1998a) reviewed 250 articles and chapters on formative assessment research and found that there was evidence that formative assessment is directly linked to learning gains and that the gains are "significant and often substantial" (p. 3). From their research, they concluded that formative assessment "helps low achievers more than other students and so reduces the ranges of achievement while raising achievement overall" (p. 3). Formative assessment help students' develop "learning to learn" skills by involving students as partners in the learning process and
emphasizing peer-assessment and self-assessment skills (OECD, 2005). Marshall (2005) sees formative assessment as benefiting not only students but also teachers and administrators as “teachers can monitor the effectiveness of their instruction and adjust their work based on solid student achievement data” (p. 3) while administrators can use formative assessment “to monitor individual school performance and provide assistance and intervention as necessary” (p. 3).

Formative assessment requires that teachers must know what their students are to learn and how they should go about teaching it. Teachers should, therefore, have an understanding of the discipline, how to organize its concepts and what tools to use (Jones and Moreland, 2005). Teachers need to know if the students are reaching the set learning goals. This implies making judgments of students’ work (where they started from, where they are and where they need to be). Teachers, therefore, need to notice, recognize and respond to students thinking during classroom interactions.

To make valid judgments about students’ work, teachers need to interpret the information they are able to gather about student learning. A good knowledge of the conceptual terrain becomes very important at this point. Teachers’ knowledge of the subject matter guides them on what to focus on in their teaching. It also affects the decisions they make on what pedagogical strategies to use (Jones and Moreland, 2005). This is important since each subject has its peculiarities. According to Black, Harrison, Lee, Marshall, & Wiliam (2004) even aspects such as questioning and interpreting of students responses require a detailed knowledge of the subject as well as an understanding of the kinds of difficulties that students might have. Thus, the general principles of formative assessment apply across all subjects but may manifest themselves
in different subjects in different ways. Teachers, therefore, need to have a clear knowledge of the concepts they are exploring and also a pedagogical understanding of how to help the students learn them. With sufficient content and pedagogical knowledge, teachers can notice, recognize and respond to students work in a productive fashion.

**Cameroon: Brief History and Geography**

This study will take place in the context of teacher professional development in Cameroon. Cameroon is located in 'Central-West' Africa (Figure 1), and is commonly described as "Africa in miniature" because it exhibits most of the major climates and

![Geographical Location of Cameroon](image)

**Figure 1: Geographical Location of Cameroon (The World Fact Book, 2008)**
vegetations of the continent. Cameroon lies between latitudes two degree north and longitudes nine degrees east and sixteen degrees east of the Greenwich Meridian (UNESCO, 1995). The land surface is about 475,000 square kilometers, and is covered by diverse landscapes, fauna and flora (UNESCO, 1995). The population is estimated at 18.5 million (The World Fact Book, 2008).

A former German colony, annexed in 1884, Cameroon became two mandated territories governed by France and Great Britain under the supervision of the League of Nations and later became trusteeships under the United Nations. After Independence in 1960 for French Cameroon and 1961 for British Cameroon, both sectors were reunified under a Federal system of government. Later through a referendum in 1972 a unitary government was formed. Cameroon is divided into ten administrative regions, with Francophones (eight of the regions) constituting about 71% while the Anglophones (two of the regions) make up the remaining 29%. Economy-wise, Cameroon's oil resources and favorable agricultural conditions helps in ranking her among the intermediate states in Africa (Tchombe, 2001) with a per capita GDP of about 2300 US dollars in 2006 (AfDB/OECD, 2007).

General Education in Anglophone Cameroon

Two distinct systems of education (Francophone and Anglophone systems) exist in Cameroon with two different sets of structures, programs, and examination practices modeled after the French and British educational systems. In Anglophone Cameroon, with respect to general education, there is a 6-5-2 system, with six years in primary school, five at the secondary level and two in high school (Figure 2). Up to the third year
of secondary school all the students take every subject but from the fourth year the
students choose a science or an arts concentration.

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**Figure 2: Anglophone Cameroon Education System**

Evaluation and certification at the end of each level of education requires students
to sit for certificate examinations. At the primary level Anglophone students take the First
School Leaving Certificate (FLSC) examination while at the secondary level they sit for
the General Certificate of Education, Ordinary Level (GCE "O" Level) and General
Certificate of Education Advanced Level (GCE “A” Level) at the end of high school. The system of education in Cameroon is therefore highly examination oriented with teachers teaching specifically for examinations (Tchombe, 2001). This greatly influences teaching and learning and it is these examinations that form the basis for making value statements about educational outcomes.

Secondary Teacher Training in Cameroon

As concerns secondary teacher education, Tambo (1995) identifies two major models in Cameroon: the non-formal and the formal models. Tambo (1995) describes the non-formal model as being similar to in-service education in the United States. It is different, though, in that it is the effort by the Cameroon Government to meet the short-term needs of secondary schools in terms of teacher supply. Over the years, the acute shortage of qualified teachers in secondary schools resulted in the government recruiting university graduates with bachelor’s degrees in specific subjects to teach in secondary schools. This means they begin teaching with almost no pedagogic training. However, there exist professional teacher associations in different subject disciplines in which these teachers can participate in seminars and workshops organized by government inspectors and various teacher groups. Therefore, for many teachers, the bulk of their teacher education follows employment and is through participation in the activities of these professional associations in their respective disciplines and their personal efforts.

Tambo (1995) describes the formal model as based on the initial education program at École Normale Supérieure (ENS), (Higher Teachers’ Training College). Selection of students into the first cycle of ENS is by an entrance examination which is
taken by holders of the GCE "A" Level, and between the ages of 17 and 30 years. For the second cycle, the candidate must be a holder of a bachelor’s degree or equivalent from a recognized university and should be between the ages of 20 and 32 years.

The training program consists of theory or content acquisition in the student’s discipline or specialization, pedagogy, and psychology, as well as field experiences or teaching practice in schools. The program lasts three years for the first cycle and two years for the second cycle. At the end of these respective periods, the candidates are required to take a final examination in their areas of specialization. They are also examined for teaching skills by their professors, government inspectors, and selected classroom teachers in the secondary schools in which the students are doing their teaching practice. In addition, second cycle students are required to submit a thesis. The successful candidates at the end of this process receive certification for teaching at their respective levels at the secondary school and are duly posted to the different schools where they begin teaching.

Private schools (which include both denominational and lay private schools) also rely heavily on university graduates with no training in teaching. Just like with the other teachers in the government schools they have to rely on some form of in-service training. According to Tambo (2001) the situation is even worsened by the reluctance of church education authorities to employ teachers trained by public training institutions. The Cameroon Baptist Convention (CBC) and the Presbyterian Church in Cameroon (PCC) in co-operation with the German Development Service (DED) have in recent years developed a more elaborate in-service training program for secondary school teachers.
The program which initially started as an in-service training program for secondary science teachers has been extended to other subjects.

**Statement of the Problem**

From formal to non-formal teacher training, assessment training is generally focused on preparing and grading of tests and examinations. In formal training, this is usually in the form of a single course on measurement and evaluation or as part of course in curriculum and instruction. This means not enough time is devoted to helping teachers develop the type of skills that will enable them help students acquire deep learning. Opanya & Toure (2003) report that, even in cases where teachers are trained, classroom activities are still characterized by some form of "rigidity" whereby teachers are dominant and the pupils are passive. According to Opanya & Toure (2003) the situation is made more complicated by large and unmanageable classes and the unavailability or poor quality of material resources. Kellaghan & Greaney (2004) reports the situation in Tanzania and other countries where little or no homework was assigned due to the lack of textbooks. Large class size made it difficult for teachers to look at students’ work and subsequently no comments were provided or problems were not identified in the students’ work.

An additional problem is the constraint imposed by high stakes testing systems such as that of the GCE in Cameroon. In a review paper on assessment and examinations in Africa, Kellaghan & Greaney (2003) enumerate some of the following problems which are associated to high stakes examinations in African countries, Cameroon included:
• Assessment is largely limited to assessing lower-level skills with the result that teaching follows the same path especially as teachers may not be adequately prepared to teach in ways that will facilitate the development of higher-order and transferable skills especially in the science curriculum.

• Examination statistics are published for each school and zone making it possible for schools to see where they are with respect to other schools in the same area. Parents use this information to “shop” for good schools for their children using the performance of each school in the examinations as “evidence”.

• By focusing on what is examined, curriculum areas that are not examined receive less attention when it comes to teaching leading to a narrowing of the curriculum.

• Teaching and learning strategies are fashioned so as to achieve the best results on these examinations. Teachers tend to rely on drill methods which promote rote learning and are generally encouraged to do so because their reputations depend on how well their pupils perform in their subjects in the examinations.

Faced with such constraints as high stakes testing, large class size, and inadequate material resources, teachers fail to systematically collect information about students’ learning and are unable to help students move towards deep learning. Teachers hardly use high stakes examinations as a means of improving instruction and learning as they serve mostly for the purposes of accountability. Many teachers hold beliefs about assessment, developed during their times as students (Marsh, 2007), which may influence their assessment practices. According to Pajares (1992), clusters of beliefs around a particular situation, in this case assessment, form attitudes which become action agendas that guide
teachers' classroom decisions and behavior. In some cases, the teachers do not even possess the knowledge needed to carry out formative assessment.

Stiggins (2002) provides an explanation of the state of assessment which he refers to as a crisis in assessment:

Student achievement suffers because once-a-year tests are incapable of providing teachers with the moment-to-moment and day-to-day information about student achievement that they need to make crucial instructional decisions. The problem is that teachers are unable to gather or effectively use dependable information on student achievement each day because of the drain of resources for excessive standardized testing. There are no resources left to train teachers to create and conduct appropriate classroom assessments. For the same reasons, administrators have not been trained to build assessment systems that balance standardized tests and classroom assessments. As a direct result of these chronic, long-standing problems, our classroom, school, and national assessment systems remain in constant crisis, and students suffer the consequences (p. 2).

Stiggins (2008) asserts that though teachers and administrators alike, need to know and understand how to assess effectively, no teacher or administrator training program includes this kind of training. Stiggins (2008) states that “tools” are now readily available to change this and teach sound assessment practices by modeling these tools.

The problem this study will be addressing is that of the absence of formative assessment and teachers' lack of formative assessment skills which hampers learning in science classrooms in Anglophone Cameroon. The study explores science teachers' initial views and practices as related to classroom assessment as well as the changes they undergo through professional development as they plan and implement lessons. This has not previously been done in a context like Cameroon with the significant constraints of high stakes testing, large class size, and inadequate material resources. The study identifies the strategies that the teachers adopt in their use of formative assessment in their classrooms when faced with these constraints. The study also identifies the
challenges they face during the course of this process and the possible support needed by the teachers in order for them to succeed.

This project takes a knowledge base approach to professional development. With knowledge base approaches to professional development, teachers draw from their shared knowledge base to improve their practice. Together they examine their students' learning of the curriculum, interpreting their students' conceptions and misconceptions, and plotting their students' learning trajectories, or devise alternative teaching practices that are more effective in helping their students master the curriculum (Hiebert, Gallimore & Stigler, 2002). Lesson study, an example of the knowledge base approach, is a professional development process initiated by teachers during which they systematically examine their practice, with the goal of becoming more effective (Chokski, 2002). Teachers choose goals that focus on skills or dispositions that they want to foster in their classrooms, and in a particular content area. Teachers then generate research questions, which have to do with exploring how to develop these skills or dispositions. Alongside these skills and dispositions, specific content goals are also articulated for each study lesson. Lesson study may take on somewhat different forms and characteristics (Lewis, Perry & Murata, 2006). The professional development used in this study employed a variety of aspects from lesson study that involved teachers choosing, planning and teaching lessons in small groups.

Research Questions

The study will be guided by the following research questions:
1. What are Anglophone Cameroon science teachers’ views and practices vis-à-vis assessment?

2. What changes do chemistry teachers make in terms of their formative assessment views and practices as they undergo professional development?

3. What difficulties do the teachers express in their attempts to incorporate formative assessment practices in their lessons? What support do they need?

Significance of the Study

To ensure deep learning, teachers need to clearly identify what each student is required to learn, when each student has learnt, and how to respond to the difficulties that students experience during learning. For this to happen, teachers need to be assessment literate, possessing adequate formative assessment knowledge. According to Stiggins (1999), relevant assessment training is important to ensure that teachers develop the ability to use the assessment process and its results in a timely manner to enhance student learning. According to Angelo (1990), teachers need to become classroom researchers by being more independent, systematic and effective in terms of inquiries into students’ learning. In Anglophone Cameroon, as in many parts of the world, science teachers generally lack the training which can enable them possess these skills. Most of them consider instruction and assessment as being separate. There is a need, therefore, for a rethinking and readjustment of beliefs and practices to use assessment for improving learning. However, in a country like Cameroon where public expenditure on education stands just at about 3.0% of the GDP (UNICEF, 2008), few resources are deployed for initial teacher training which means not enough time is devoted for student teachers and
practicing teachers to reflect on their assessment practices. With the lack of resources for training and a lack of formal training, many teachers may not possess skills such as those needed to effectively carry out formative assessment. There is the need to adopt professional development practices that will help teachers acquire these skills by using cheap and locally available resources. The use of a knowledge base approach gives teachers a meaningful role in professional development and can be implemented anywhere at a low cost.

Many studies on formative assessment have been conducted in the western world where class sizes are rather small and material resources are not significant constraints. This study is significant in that it provides valuable information about how teachers with little or no training take charge of improving their formative assessment practice especially in a high stakes testing environment further complicated by constraints such as large class size and lack of material resources. Through this study the successes and difficulties associated with teachers' use of formative assessment as they are get involved in professional development could be understood. This will help to inform and improve on professional development not only in the area of formative assessment but also in other areas of science pedagogy especially in regions where science teaching is hampered by the unavailability of human and material resources.

Overview of the Methodology

Preliminary data about teachers' assessment beliefs and knowledge was collected through a survey of 28 teachers. Eight teachers were selected to participate in the professional development program. These teachers participated in a group discussion
about assessment and were observed in their classrooms. From these observations, their initial practices as related to formative assessment were documented. Their individual views were also documented through individual interviews after the lessons. An orientation workshop was offered to the participants to acquaint them with the process of formative assessment as well as the lesson planning and implementation process that was to be used in the study.

Two separate groups of teachers then chose, planned, taught, revised, and re-taught a lesson. One member of the group taught the planned lesson while the rest of the group and other observers took notes. At the end of each lesson (both when it was taught and when it was re-taught) all those involved came together for a post-lesson discussion. From the teachers' teaching of the research lessons and reflections, changes in views and practice were determined. Group reflections and discussions at the end of the whole exercise provided an indication of the participants' final thoughts on the use of formative assessment for improving their students' learning skills. Through all these activities it was possible to explore the teachers' shifts in perspective as concerns formative assessment.

Conclusions

Formative assessment plays a vital role in students' learning in science. Teachers need adequate formative assessment skills to be able to navigate with students confidently towards their learning goals. However, the majority of science teachers in Anglophone Cameroon do not receive training in and are not familiar with the principles or practices of formative assessment. In fact, many teachers receive no formal pedagogic
training. As such, they rely on professional associations for the acquisition of teaching skills. For professional associations to be able to help teachers in the acquisition of these skills, they need to adopt a pragmatic approach. Teachers working in small or large groups can improve not only their assessment for learning skills but other skills which will help improve students' learning in science by developing reflective attitudes. Professional development through such on-site approaches is thus an option worthy of consideration. This study aims at investigating the strategies teachers' adopt in their classrooms as they are engaged in formative assessment training.
CHAPTER II

LITERATURE REVIEW

Introduction

This chapter presents the literature that is relevant to this study. The chapter starts by reviewing some definitions of formative assessment, the value of formative assessment for student learning, and how formative assessment differs from summative assessment. Then, it describes different assessment methods, the types of feedback given to students, and how students can be involved in the assessment process (peer and self assessment). The chapter presents some models of formative assessment. It also reviews some obstacles to the use of formative assessment and how approaches such as professional development can ameliorate the situation.

Assessment and Formative Assessment

Assessment has a significant impact on teaching and learning (Dochy & McDowell, 1997; Dochy, 2001) which can either help or obstruct endeavors aimed at improving teaching and learning (Boud, 1995). According to Boud (1995), students adopt different study approaches depending partly on the form and nature of the assessment tasks they encounter, using surface approaches in some instances and deep approaches in others. Recently there has been a dramatic shift in views towards the use of assessments as tools to enhance deep learning (Dochy & McDowell, 1997; Dochy, 2001; Shepard, 2000; Stiggins, 1992; Black & Wiliam, 1998b; Angelo, 1990). Formative assessment, assessment for learning, learner-centered assessment, and classroom assessment, are
some of the names that have been used to describe this type of assessment. In this study, *formative assessment* is the preferred term as it is the term that has been most frequently used by many educationists. Many, (e.g. Stiggins, 2002), see formative assessment as being as important as summative assessment in improving classroom learning and teaching and call for more investments in formative assessment so that the two can be more balanced.

Formative assessment requires that teachers monitor and guide learners in the course of learning. Teachers must therefore plan activities which involve and empower students while gauging their learning and providing effective feedback which can help students attain set goals. This chapter looks at the different ways that teachers can monitor student activities (assessment methods or information collection methods), the types of feedback given to students, and how students can be involved in the assessment process (peer and self assessment). The chapter, before delving into these aspects of formative assessment, reviews how formative assessment is defined and how it differs from summative assessment. Some models of formative assessment are also presented. Considering that many teachers do not use formative assessment strategies it is necessary to review some obstacles to the use of formative assessment and how professional development can ameliorate the situation. This is especially important as this study looks at the changes and adaptations that teachers make in their use of formative assessment when faced with obstacles such as the prevalence of high stakes testing and lack of resources.
Formative Assessment: Differences with Summative Assessment

Teaching Standard C of the National Science Education Standards (NRC, 1996) advocates that science teachers should engage in ongoing assessment of student learning as well as the instruction process. In this process, teachers should systematically gather information about student learning through the use of multiple methods; analyze the data collected; help students in developing self-assessment strategies; and use the information to improve and report on teaching and learning. Black, et al. (2004) consider formative assessment as helping students identify where they are trying to go in the learning process, where they are at a particular moment, and how they can get to where they are trying to go. Formative assessment takes place in the course of learning; it involves gathering information about students' learning; it involves interpreting the information; and deciding on the best strategies to use in order to progress. Assessment can, therefore, be known as formative assessment only when either the teacher and/or the student use the information which is gathered during the learning progress to improve on teaching and learning.

Much value has been placed on the use of formative assessment. The review by Black & Wiliam (1998a) of 250 assessment articles indicates strong evidence in favor of the use of formative assessment. Substantial achievement gains have been associated with formative assessment. Formative assessment improves equity of student outcomes as much higher gains are recorded for previously underachieving students (OECD, 2005; Black & Wiliam, 1998b). This is possible as the students have a clear view of the learning intentions, are more focused on and involved in the learning process, and their progress can be tracked diagnostically (Marsh, 2007). Formative assessment improves
students’ “learning to learn” abilities by emphasizing the process of teaching and learning, and making students’ valuable partners in this process (OECD, 2005). Through the use of self and peer assessment, the students are empowered to have effective control over their learning, thereby staying motivated throughout the learning process. In a nutshell, the use of formative assessment provides students with invaluable lifelong learning skills as it enables students to actively build their understanding of new concepts, and learn to judge the quality of their work and that of their peers’ against well-defined criteria. This is why some educational researchers (e.g. Stiggins, 2002) are referring to formative assessment as ‘assessment for learning’ which is very different from summative assessment or what others call ‘assessment of learning’, which takes place at the end of the learning process so as to see what learning has taken place. Figure 3, known as the formative assessment cycle (Harlen, 2003), can be used to summarize the formative assessment process.

Figure 4 on the other hand, shows summative assessment which is used to describe learning achievement at particular times such as end of semester or end of year for the purposes of informing parents, teachers, the pupils themselves or other stakeholders such as school administrators and policy makers. Information for summative assessment is usually obtained by administering tests and exams and it is really doubtful if this really reflects the full extent of learning achieved by the learners. Summative assessment is important in the overall educational progress of learners but not in day-to-day teaching as does formative assessment (Harlen & James, 1997). As such summative assessment does not have the much direct influence on student learning as does formative assessment does.
Table 1 presents some differences between formative assessment and summative assessment. Formative assessment is generally directed at improving teaching and learning. Its ultimate intention is to help students in the learning process with the main benefactors of the process being the learners. Summative assessment, on the other hand, is concerned mainly with the accountability of schools and education systems. The users of
summative assessment, mostly schools and districts, are often concerned with how a school or student compares with other schools or students. Formative assessment requires that the learners play an active role in the learning process. The assessment process requires that one assesses himself/herself and one’s peers with the teacher assuming a leading role. With summative assessment, students play no significant role and teachers may or may not be part of designing the assessment process. In some cases outside professionals are used for the assessment process and may not know the persons they are assessing (Fulcher & Davidson, 2007).
# Table 1

**Main Differences between Formative and Summative Assessment**

<table>
<thead>
<tr>
<th>Formative Assessment</th>
<th>Summative Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Primary Users</strong></td>
<td><strong>School, district or region</strong></td>
</tr>
<tr>
<td>• Classroom teacher</td>
<td>• Classroom teacher</td>
</tr>
<tr>
<td>• Student</td>
<td></td>
</tr>
<tr>
<td><strong>Intent/Uses</strong></td>
<td><strong>Verify individual and group mastery of specific objectives</strong></td>
</tr>
<tr>
<td>Supports learning by:</td>
<td><strong>Identify students needing more help</strong></td>
</tr>
<tr>
<td>• helping teachers diagnose and respond to student needs</td>
<td><strong>Provide instructional feedback to teachers</strong></td>
</tr>
<tr>
<td>• having teachers adjust instruction based on results</td>
<td><strong>Identify objectives not well mastered</strong></td>
</tr>
<tr>
<td>• enabling students to take responsibility for their own</td>
<td><strong>Communicate evidence of performance</strong></td>
</tr>
<tr>
<td>learning through self-assessment, goal-setting,</td>
<td></td>
</tr>
<tr>
<td>communicating their own progress, etc.</td>
<td></td>
</tr>
<tr>
<td><strong>Tasks and Emphases</strong></td>
<td><strong>Specific Instructional Objectives (fewer in number-usually determined by local curriculum maps or pacing guides)</strong></td>
</tr>
<tr>
<td>• Instructional objectives broken down into small explicit</td>
<td></td>
</tr>
<tr>
<td>learning targets that help students master objectives</td>
<td></td>
</tr>
<tr>
<td>• Focus on one aspect of quality at a time</td>
<td></td>
</tr>
<tr>
<td><strong>Methods</strong></td>
<td><strong>Selected response (multiple choice)</strong></td>
</tr>
<tr>
<td>• Requires use of many assessment methods to provide a</td>
<td><strong>Constructed response (short answer)</strong></td>
</tr>
<tr>
<td>continuous stream of accurate evidence of students'</td>
<td><strong>Often generated from test item banks that are aligned with Content Standards</strong></td>
</tr>
<tr>
<td>mastery of knowledge, reasoning, performance skills,</td>
<td></td>
</tr>
<tr>
<td>etc.</td>
<td></td>
</tr>
<tr>
<td>• Assessment methods: paper and pencil, performance and</td>
<td></td>
</tr>
<tr>
<td>personal communication</td>
<td></td>
</tr>
<tr>
<td><strong>Timing</strong></td>
<td><strong>Periodic (three, four or five times during the year)</strong></td>
</tr>
<tr>
<td>• Ongoing, interconnected series revealing patterns in</td>
<td></td>
</tr>
<tr>
<td>student learning</td>
<td></td>
</tr>
</tbody>
</table>

*Source: Adapted from Classroom Assessment for Learning (West Virginia Department of Education, 2008)*
In summative assessment tasks are made different as much as possible from each other and students are often restricted to short time intervals to complete the tasks. According to Dochy (2001), for formative assessment tasks to be most effective, they have to be interlinked and broken down into small explicit learning sections, often with no time pressure. Formative assessment tasks often take many different, engaging, and meaningful forms such as group activities and projects which are less threatening (Harlen & James, 1997; Dochy, 2001) unlike summative assessment which looks at single scores. This makes formative assessment criterion-referenced as opposed to summative assessment which may be either criterion referenced or norm-referenced.

Formative assessment is ongoing and requires the use of many assessment methods to provide a continuous stream of accurate evidence of students’ mastery of knowledge or performance while summative assessments use mostly selected or constructed response items and are administered three, four or five times during the year.

Models of Formative Assessment

Different researchers (Cowie & Bell, 1999; Shepard, 2000; Harlen, 2003) have provided different models of formative assessment. Harlen (2003) provides a simple and straightforward model which focuses on the student. Harlen’s framework is summarized by Figure 3. According to Harlen, if teachers are to help students learn, they need to have a clear idea of the learning goals and be able to identify where the students are on their path to attaining these goals. The formative assessment cycle requires that the teacher collects information about student learning. With clear goals in mind, the teacher then proceeds to provide students with experiences through which he can collect evidence
about their learning. The different methods through which information about student learning is collected are discussed below.

With the collection of assessment information, the next step in the formative assessment cycle, according to Harlen (2003), involves interpretation of the evidence on student learning. This means that the teacher has to carefully examine the information collected, comparing it with the intended goals as well as the students' previous position. The teacher then uses this information to decide on the next steps to take in order to help the student move towards the attainment of the learning goals. This is very crucial because ideally the decisions made by the teacher have to match each individual student's needs. Once the teacher decides on the next steps to be taken in helping the students, he plans and organizes strategies that will be used. According to Harlen (2003), these strategies fall into three categories: “helping students test their ideas, providing access to alternative scientific ideas, and enhancing communication and reflection” (p. 24-25). This is what is otherwise known as providing feedback to the students. Feedback to students is an important part of the process of formative assessment if the students are to understand how their existing conceptions relate to the scientifically accepted ones. At this point the teacher provides experiences which will expand students' ideas, linking, and creating a network of ideas.

Cowie & Bell (1999) from their study with 10 teachers on formative assessment describe a framework similar to that of Harlen (2003) but reports two types of formative assessment: planned and interactive formative assessment. The planned process involved teachers eliciting, interpreting and acting on the information collected. Cowie & Bell
(1999) explain that the purpose of the planned assessment largely determines how the information is collected, interpreted and acted upon. This, they represent by Figure 5.

**Figure 5: Planned Formative Assessment (Cowie & Bell, 1999)**

Interactive formative assessment, on the other hand, refers to the type of assessment that takes place during the teachers' interactions with students, and differs from planned formative assessment in that it is never planned. This type of assessment arises from the learning activities taking place in the classroom such as one-to-one, small-group, and whole-class discussions. According to Cowie & Bell (1999), the process involves the teacher being able to notice, recognize and respond to students' thinking during class interactions. Figure 6 represents the interactive assessment learning cycle.

**Figure 6: Interactive Formative Assessment (Cowie & Bell, 1999)**
Shepard (2000) explains a social-constructivist approach to assessment with aspects similar to that proposed by Harlen (2003) and Cowie & Bell (1999). Shepard (2000) proposes that for assessment to support the social constructivist model of teaching, the content and form of assessment must change in such a way as to promote higher order thinking. She proposes that classroom assessment must be directly linked to instruction. To achieve this, students must have clear understanding of what goals they are expected to attain. An important aspect of her framework is the elicitation of students' prior knowledge. This makes formative assessment an on-going and dynamic process which can be at the beginning, middle or end of a lesson. Shepard (2000) equally stresses the importance of feedback especially in helping students in the understanding of important concepts as well as being able to transfer the new knowledge to new situations. In this process, it is important to make students assessors of their own work as it not only helps them cognitively but also serves to increase their responsibility toward their own learning. Using this framework, teachers are expected to critically examine and modify their practices in order to improve student learning.

Methods of Collecting Information about Student Learning

In the assessment process teachers can use a variety of methods to collect evidence about students' learning. This can be through written communication (paper and pencil), performance assessment, or personal communication methods (Stiggins, 1992). Table 2 provides a summary of assessment information collection methods. The use of oral questioning, as a form of personal communication, has received particular attention
as it widely used in classrooms due to the ease in administering questions. It is worthwhile to review some important aspects of teacher questioning.

Table 2

Summary of Classroom Assessment Options

<table>
<thead>
<tr>
<th>Methods</th>
<th>More Objective Forms</th>
<th>More Subjective Forms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Written communication</td>
<td>Multiple choice</td>
<td>Minute papers</td>
</tr>
<tr>
<td></td>
<td>True-false</td>
<td>Open questionnaires</td>
</tr>
<tr>
<td></td>
<td>Matching</td>
<td>Essays</td>
</tr>
<tr>
<td></td>
<td>Closed questionnaires</td>
<td>Concept maps</td>
</tr>
<tr>
<td>Performance assessment</td>
<td>Checklist of attributes present or absent in performance</td>
<td>Observing students as they describe their work</td>
</tr>
<tr>
<td>Personal communication</td>
<td>Instructionally relevant questions</td>
<td>Interviews, group and whole class discussions</td>
</tr>
</tbody>
</table>

Orlich et al. (2004) considers classroom questioning as the single most widely used teaching technique next to lecturing, and small-group work. For this reason, teachers must be able to ask questions that will help students attain the specified lesson objectives. Research has shown that teachers do not systematically plan their questions in ways that will meet students' learning needs. According to Roth (1996) some teacher questions may have the purpose of controlling the social situation in the class or of differentiating students rather than helping students in the learning process.

Different approaches have been used to classify teachers' questions. According to Gall (1970), many question-classification systems are based on the type of cognitive process required to answer question. Bloom's Taxonomy (1956), represents one of the common systems and many of the classification systems closely resembles Bloom’s
classification system. Bloom's classification places questions in six cognitive levels of ascending order of sophistication: (1) knowledge, (2) comprehension, (3) application, (4) analysis, (5) synthesis, and (6) evaluation. These six levels of questions have been have been grouped into 2 simple categories which have been called higher and lower cognitive questions. Lower cognitive questions are those that require students to merely recall previously read or learned facts. These lower cognitive questions have also been referred to in the literature as closed, direct, or convergent questions. Higher cognitive questions are those that require students to mentally manipulate pieces of previously learned information to answer a question. Higher cognitive questions have also been called open-ended, inquiry, or divergent questions.

According to Dillon (1982) in Orlich et al. (2004), on the average, during classroom recitations, approximately 60 percent of the questions asked are lower order cognitive questions, with 20 percent being higher cognitive questions, and 20 percent procedural. Cotton (1988) states that increasing the number of higher cognitive questions results in higher learning gains, particularly, for students above the elementary grades.

Harlen (2006) proposes another type of question classification (summarized in Table 3) which does not depend on the different cognitive levels but which helps in revealing students ideas. Harlen (2006) explains that person-centered questions are the useful questions for eliciting students' ideas because they ask students to explain what they think, rather than asking for correct explanations and by asking students what they think, they are not under any pressure to be “right”. Harlen (2006) further states that questions which are both open and person-centered are the most useful in classrooms
because they give students the opportunity to express their ideas rather than just agreeing or disagreeing with stated ideas. This could be very important in inquiry classrooms.

Table 3

<table>
<thead>
<tr>
<th>Question Type</th>
<th>Description of Question Types</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subject-centered questions</td>
<td>These are questions that have one right answer because they ask for explanations of science phenomena</td>
</tr>
<tr>
<td>Person-centered questions</td>
<td>These are questions that students that ask they think are possible explanations of the phenomena involved in an activity. There is no &quot;right&quot; or &quot;wrong&quot; answer.</td>
</tr>
<tr>
<td>Process-centered questions</td>
<td>This are questions that ask students to do something such as observing, planning, measuring, etc. which requires them to use process skills, but without asking of the phenomena involved</td>
</tr>
<tr>
<td>&quot;Other&quot; types of questions</td>
<td>Some questions do not fit into any of the above categories. They fall into this category.</td>
</tr>
</tbody>
</table>

The basic suggestion for asking questions, according to Orlich et al. (2004), is for the teacher to ask a question, pause, and then call a student to answer the question. This suggestion is based on the premise that, when a teacher asks a question, followed by a pause, known as wait time 1, every student will pay attention since they know that they will have enough time to engage the question and that any student could be selected to give a response. This gives students the opportunity to think about their responses, especially when asked higher-order questions. Observing such as pause gives the teacher
the chance to observe the class and decide on which student to call. After the student responds, it is important for the teacher to observe a second pause, called wait time 2, before making any further comments. This second pause allows students to continue to think and respond as well. Figure 7 illustrates this suggestion for oral questioning.

![Diagram of Wait Time 1 and 2: (Orlich et al. 2004)](image)

**Figure 7: Wait Time 1 and 2: (Orlich et al. 2004)**

In her studies, Rowe (1974, 1986) was able to show that when wait time increased, the length of student responses increased, the number of unsolicited responses also increased while failure to respond decreased. Students also showed more confidence in their responses, became more reflective, and the frequency of asking questions increased. When teachers waited patiently in silence for 3 or more seconds at appropriate places, positive changes also occurred in their own teacher behaviors: they became more flexible in their questioning, their questioning patterns became better and more manageable, and their expectations for slow learners improved. Rowe (1974), however,
showed that typically wait time 1 was on average one second when students did respond. When they failed to respond, the teacher repeated the question, rephrased the question, asked another question, or called on another student. Also, wait time 2 was on average 0.9 seconds with the teacher reacting to the students’ response or posing another question.

Feedback in Formative Assessment

At the center of formative assessment is the concept of feedback. Feedback with regard to formative assessment has a powerful influence on learning as well as achievement (Hattie & Timperley, 2007). Shute (2008) also regards feedback as being crucial and defines it as information which is communicated to learners in order to modify the way they think or behave with the sole intention of improving learning. According to Hattie & Timperley (2007) this information can be provided in a variety of ways, for example by a teacher or parent in the form of correction, by a peer in the form of an alternative strategy, from some resource such as a book which can provide information to clarify ideas, or the learner can look up the information themselves to evaluate the correctness of a response.

Different categorizations of feedback have been proposed with regards to the different functions of feedback. Table 4 shows four such categorizations. Two of these categorizations, Shute (2008) and Tunstall & Gipps (1996), show some form of feedback continuum.
Table 4
Categorizations of Feedback

<table>
<thead>
<tr>
<th>Reference</th>
<th>Feedback Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Elaboration</td>
<td>Elaboration involves providing relevant cues to guide the learner toward the correct answer.</td>
</tr>
<tr>
<td>Tunstall &amp; Gipps (1996)</td>
<td>Evaluative</td>
<td>Feedback is judgmental being generally positive or negative.</td>
</tr>
<tr>
<td></td>
<td>Descriptive</td>
<td>Feedback is task related, focusing on achievement and improvement.</td>
</tr>
<tr>
<td>Black &amp; Wiliam (1998a)</td>
<td>Directive</td>
<td>This is specific feedback which tells the student what needs to be corrected or revised.</td>
</tr>
<tr>
<td></td>
<td>Facilitative</td>
<td>Facilitative feedback provides comments and suggestions on how to carry out the revision therefore helping conceptualization.</td>
</tr>
<tr>
<td>Harlen (2006)</td>
<td>Judgmental</td>
<td>Relates to the student or the quality of work in a way that does not states why the work is not good leading to students labeling or comparing themselves with to others.</td>
</tr>
<tr>
<td></td>
<td>Non-judgmental</td>
<td>Focuses on the task at hand, offering encouraging comments which help student to think of their work.</td>
</tr>
</tbody>
</table>

Shute (2008) shows the continuum starting from a point of no feedback through verification, which has different sub-categories arranged in order of complexity, to elaboration, which is also arranged in order of complexity (Table 5). The lowest level of verification involves informing the learner of the correct answer by simply saying 'correct', 'incorrect', 'yes' or 'no'. Next on this continuum are more implicit forms of verification which involve informing the learner about an incorrect response and allowing
him or her to attempt another answer or highlighting errors in a particular solution but without providing the correct answer. Elaboration feedback in its simplest form would require the teacher to address the topic or concept being studied or particular response thereby providing the student with more information.

Table 5
Feedback Sub-categories (Shute, 2008)

<table>
<thead>
<tr>
<th>Verification</th>
<th>Elaboration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Correct response</td>
<td>Attribute, topic or response contingent</td>
</tr>
<tr>
<td>(informs learner of correct answer)</td>
<td>(provides information on the concept or topic being studied or on the specific response)</td>
</tr>
<tr>
<td>Try again</td>
<td>Hints, cues and prompts</td>
</tr>
<tr>
<td>(informs learner of answer but allows attempts to answer)</td>
<td>(provides strategic hint on what to do next, worked example or demonstration)</td>
</tr>
<tr>
<td>Error flagging</td>
<td>Bugs and misconceptions</td>
</tr>
<tr>
<td>(highlights errors in answer but gives no solution)</td>
<td>(provides information about learner’s specific response or misconception)</td>
</tr>
<tr>
<td></td>
<td>Informative tutoring</td>
</tr>
<tr>
<td></td>
<td>(involves error flagging and strategic hints on how to proceed)</td>
</tr>
</tbody>
</table>

Higher forms of elaboration feedback require the provision of hints, scaffolding, or prompts to the students or provision of specific errors or identification of misconceptions. At the highest form of elaboration feedback, the teacher together with the student, walk through the problem to arrive at the correct answer. In each of the elaboration cases the teacher does not provide the correct answer.
Tunstall and Gipps’ (1996) categorization, as shown in Figure 8, closely resembles that of Shute (2008). At one of the continuum (A1 and A2 on the left), is feedback which could be positive or negative. This involves rewarding or punishing the students depending on whether their responses are correct or wrong. Next are B1 and B2 which, like A1 and A2, are also evaluative in nature. Positive forms will include praising the student and positive non-verbal expression while negative forms will include reprimands and negative non-verbal expressions. C and D categories are descriptive forms of feedback which could either specify achievement (C1 and D1) or specify improvement (C2 and D2). Whereas C1 and D1 specify achievement, C2 and D2 specify and construct the way forward. D2 is at the other end of the continuum because it involves both the teacher and student seeking strategies together to chart the way forward.

<table>
<thead>
<tr>
<th>Positive Feedback</th>
<th>A1</th>
<th>B1</th>
<th>C1</th>
<th>D1</th>
<th>Achievement Feedback</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rewarding</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Constructing achievement</td>
</tr>
<tr>
<td>Approving</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Specifying Attainment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constructing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Improving</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Descriptive</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Negative Feedback</th>
<th>A2</th>
<th>B2</th>
<th>C2</th>
<th>D2</th>
<th>Improvement Feedback</th>
</tr>
</thead>
<tbody>
<tr>
<td>Punishing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Disapproving</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Specifying Improvement</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constructing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The way forward</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 8: Feedback Continuum (Tunstall and Gipps, 1996)
Obstacles to the Use of Formative Assessment

Deeply rooted beliefs about assessment and its role in teaching and learning remains an obstacle to the use of formative assessment strategies by teachers (Shepard, 2000; Stiggins, 2001). According to Shepard (2000), many teachers rely a lot on summative assessment in the classroom with little emphases on formative assessment. This is thought to result from teacher beliefs which are consistent with principles of scientific measurement; they believe that assessment should be uniform in order to ensure fairness. For this reason they see assessment as official and divorced from the process of teaching and learning (Shepard, 2000). This is made worse by fears that formative assessment strategies are time-and resource-intensive (OECD, 2005). In a review article about assessment beliefs, Stiggins (2004) cites some common beliefs about the use of assessment in classrooms and schools that conflict with the use of formative assessment:

• that high stakes examinations are necessary to motivate students to learn
• that once a year instructional decisions have the greatest impact on student learning
• that instructional decisions taken entirely by adults contributes the most to student learning
• that the principles of sound assessment practice is the job of professional testing agencies and not that of teachers and administrators

The impact of these beliefs, according to Sitggsins (2004), is that students have been discouraged and defeated instead of being motivated, playing little or no role in the assessment process especially as assessment continues to be separated from instruction. According to Shepard (2000), any attempt to change assessment practices making
assessment an important part of the learning process must acknowledge the presence of these beliefs.

Reliance on high stakes assessment and the presence of policies which encourage this put so much pressure on teachers that they have no time left to help students in attaining learning goals. There is much tension and conflict (Black & Wiliam, 1998b, OECD, 2005) with teachers giving in to summative assessment strategies since this is used by administrators and others for the purpose of accountability. According to Black & Wiliam (1998b), this leads to teachers using these strategies to ‘drill’ students to produce right answers to questions that are often in the form of multiple choice questions.

There is a mismatch between assessment and evaluation at the policy, school and classroom level (OECD, 2005). At the policy level intentions are different from those at the school, or classroom level. Administrators and donors use information obtained through high stakes tests to decide on investments and support for schools. Parents also use this information to take decisions concerning the children. At the classroom level what is needed are strategies to help students understand the relevant concepts.

Infrastructural problems play a role in teachers not being able to use formative assessment in the classrooms. Large class sizes and lack of resources in some classrooms, discourages teachers from trying out formative assessment strategies (OECD, 2005). With large classrooms, new or inexperienced teachers are more concerned with classroom management issues than trying out strategies that will help students learn. Some teachers would prefer more time to use in getting involved with students and other teachers to discuss students’ work and how to help them. Hectic school schedules normally leave no time for such activities (Black & Wiliam, 1998b). As such it is
difficult for teachers who are willing to help students or seek help from other teachers to do so.

For teachers to observe, document and make decisions about students' learning, they need certain skills (McNamee & Chen, 2005). Studies on assessment literacy show that a good number of teachers generally lack these assessment skills (McNamee & Chen, 2005; Stiggins (1991, 1999). According to Stiggins (2002) many teachers are not able to face the challenges linked with formative assessment because they have not been given the opportunity to learn to do so. There are few opportunities for teachers to learn how to assess classroom learning. This leads to a "misdiagnosis of students' needs and misunderstanding of their own abilities" (Stiggins, 2002, p. 6). It is even difficult for teachers to have any support as far as formative assessment is concerned from principals and other administrators because most principals and administrators themselves do not have a clear understanding of what formative assessment entails.

Improving Formative Assessment Practice

Reducing Obstacles

To improve formative assessment, Black & Wiliam (1998b) propose that all obstacles obstructing this practice should be critically examined to see how their negative effects can be reduced. They see the main negative effect as coming from standardized testing and argue that with any formative assessment program there is the need to use summative assessment practices in a more helpful manner. OECD (2005) states that summative and formative types of assessment can be aligned by addressing the tensions between them, and ensuring stronger reliability and validity of the summative practices. This is where policy comes into play. OECD (2005) proposes that policy officials should
consider multiple measures of determining student progress while Black & Wiliam (1998b) propose a greater role for summative assessments for accountability purposes. They argue that by giving teachers a greater role, the teachers will have access to students' performances in variety of contexts and over an extended period of time. With this and a reduction of the number of students assigned to classrooms, provision of resources to teachers within the school and outside of the school to help them carry out formative assessment practices, and with support from administrators and parents there could be great improvement in the practice of assessment for learning (Black & Wiliam, 1998b; Atkin, et al., 2001). Policy can also play a strong role by building strong links between research, and practice by developing and investing in research and literacy programs for practitioners and policy officials as well creating centers and databases for the storing and dissemination of research results (OECD, 2005).

Involving Students in the Assessment Process

According to Harlen (2003), students and teachers should be working together in the formative assessment process rather than being on opposing sides with the teacher dragging the students reluctantly along. Self- and peer-assessment (Black & Wiliam, 1998b; Sluijsmans, Dochy & Moerkerke, 1999; Boud, Cohen & Sampson, 1999) are two strategies that have been used to get students involved in the formative assessment process. Self-assessment is a process during which a learner reflects and makes judgment about her own learning with respect to stated criteria (Boud & Fakchikov, 1989; Andrade & Valtcheva, 2009). Peer-assessment as a process by which groups of individuals make judgments about their peers' learning (Fakchikov, 1995).
Quite a number of benefits have been attributed to the use of self and peer assessment. According to Black & Wiliam (1998b), when students become involved in self-assessment and peer-assessment they are more committed and effective as learners as their own assessments becomes an important part of the learning discussion. Self-assessment is important to learning because it helps students set goals, reflect on where they are with respect to these goals, and what it will take to close the gap. By getting students involved in such reflective practices, teachers are helping them develop metacognitive skills (Topping, 2009). Self assessment can be done by having students look at their own work and rate their ability. This typically requires the teacher to facilitate a discussion or prepare a rubric to guide the students in assessing their work. In addition to being able to assess themselves, less time is used in the assessment process and feedback is almost immediate. Teachers can also encourage students to keep portfolios through which they are able to reflect on their learning, establish goals for future learning, and decide on how to achieve these goals (Sluijsmans, Dochy & Moerkerke, 1999).

Black & Wiliam (1998b) consider peer assessment important in that students may more readily accept criticisms of their work from one another than from the teacher. They feel that this is also valuable because the rapport between students is different from that between the students and the teacher and discussions will more likely be in the students’ own common “language”. According to Black & Wiliam (1998b) peer assessment can help foster high levels of involvement and responsibility by students keenly observing and having a good knowledge of their peers’ work. By getting students involved in peer assessment they are developing skills which are vital in inquiry learning. Students learn
to work together as a group; they are able to reflect and explore more as group; they make gains in communication skills and above all they are focusing on the learning process. Peer assessment, therefore, can be a very important way of complementing various forms of collaborative learning (Topping, 2009). With feedback being an important aspect of formative assessment, peer assessment becomes vital in that feedback is not only immediate but also abundant. Having immediate feedback through peer assessment saves time once students get acquainted to using it and also provides feedback from multiple perspectives, not just the lone and often “authoritative” perspective of the teacher (Topping, 2009). Above all, peer assessment like self assessment, can lead to cognitive gains. As students assess their understanding, they are able to identify earlier errors and misconceptions which lead to conceptual change. Learning and achievement is boosted as students can generalize learning to novel situations through increased reflection (Topping, 2009; Andrade & Valtcheva, 2009) as a result of self and peer assessment.

Some important guidelines to consider in the implementation of self and peer assessment (Topping, 2009; Andrade & Valtcheva, 2009) include:

- Clarifying all expectations and the nature of the products of learning to be assessed.
- Involving students in developing and clarifying assessment criteria.
- Providing training, examples, and practice on self and peer assessment
- Providing guidelines, checklists, rubrics and timelines
- Monitoring, coaching and providing feedback
Changing Teachers’ Formative Assessment Practice

Many teachers are not able to use formative assessment which according to Stiggins (1999) is because they lack some degree of competence to use them. For teachers to develop this competence they need to be given opportunities to do so (Stiggins, 2002). According to Black & Wiliam (1998b) and OECD (2005), teachers need to be provided with professional development opportunities focused on formative assessment. Black & Wiliam (1998b) see one effective way of doing this as having teachers working in small local groups and collaborating with other groups in developing formative assessment practices. In this way, the teachers would benefit from the support of policy officials, administrators, and external evaluators in the development, documentation and dissemination of assessment for learning strategies.

Professional Development and Formative Assessment Literacy

In situations where formative assessment practices are used to support learning, the dividing line between instruction and assessment blurs or dissolves (Leahy et al., 2005; McNamee & Chen, 2005). Leahy et al., (2005) states that:

Everything students do – such as conversing in groups, completing seatwork, answering and asking questions, working on projects ... (or) even sitting silently and looking confused – is a potential source of information about how much they understand (p. 19).

The teacher needs to be able to gather important information about student learning in each of these cases and make crucial decisions which will propel students along their learning paths. Leahy et al., (2005) sees this process as being challenging in that the amount of information to be processed could be overwhelming and likened to “negotiating a swiftly flowing river” (p. 19). In their study with teachers, Leahy et al.,
(2005) identified some broad categories of strategies that could be used by teachers of almost every content area. These include:

- clarifying and sharing learning intentions and criteria for success
- engineering effective classroom discussions, questions and learning tasks
- providing feedback that pushes learning forward
- making students owners of their own learning
- helping students become instructional resources for one another

These strategies or skills are what make an individual formative assessment literate as referred to by Stiggins (1991, 1999 & 2002). These are broad domains and how they are used by each teacher will vary from one context to another. According to Black et al. (2004), these general strategies are bound to have limits, from one subject to another, as simple aspects such as questioning and interpretation of responses may require a detailed knowledge of the subject matter. Jones & Moreland (2005) argue that teachers need to develop a clear sense of what the particular subject is all about as well as its organizing concepts and tools. This means having a good idea of the conceptual terrain and the pedagogical knowledge to use in helping students understand the big ideas of the subject.

However, Schafer (1991) states that only about half of teacher education programs in the United States require a course in measurement for initial teacher certification and when such a course is offered, its emphasis is not on classroom assessment. Stiggins (1991) explains that a very small number of teachers feel confident they are able to meet the demands of classroom assessment. This means teachers, whether formally and informally trained, lack basic formative assessment skills and as such cannot diagnose students learning needs. According to Stiggins (1991 & 2001) they
therefore need relevant classroom assessment training. According to Stiggins (2001), teachers are not able to get help from administrators as they themselves often lack basic formative assessment skills.

Different researchers have proposed different ways to improve teachers' formative assessment skills. McNamee & Chen (2005) used the “Bridging Assessment Process” in which teachers' measured pupils' performance in 19 curriculum-embedded activities that show their readiness to learn in five key areas over the course of the year. The teachers were able to learn how to keep track of each individual student's performance in each activity throughout the year. Teachers were provided with an assessment package which included descriptions of the different activities, rubrics and other suggestions on how to help expand students learning. The teachers met once a month to learn about bridging theories, strategies for implementation, ways to assess and analyze pupils' performances and how to translate the results into improved teaching and learning. Having the program span over the course of the year provided the teachers with opportunities to try different ideas, analyze and reflect on them during seminars, and then returning to the classroom with new ideas. This provided a procedure for refinement of ideas. This helped them in seeing and helping each student as a single learner which is particularly important in formative assessment in that it provides the opportunity to help each student. The bridging program also focused on key concepts from standards. This provided an increased understanding of these concepts for the teachers helping them set better goals and objectives in the classroom (McNamee & Chen, 2005).

Leahy et al., (2005) explored how they could introduce teachers to the key ideas of formative assessment. In one model, they held a three-day workshop to introduce
teachers to the main ideas of formative assessment. This was followed by techniques through which teachers could take formative assessment into the classroom. In the following year, they met monthly with the teachers to discuss their successes and difficulties. They also observed their classrooms to get an idea of the extent of their implementation of formative assessment practices. Teachers were offered a range of low-cost, low-tech, and feasible techniques to use for implementing formative assessment practices. Leahy et al., (2005) found that different teachers found different aspects of formative assessment useful and that it was not possible to develop a “one-size-fits-all package” (p. 20). This meant that it was important to teach teachers a range of techniques and how to customize them to meet their specific classroom needs. Shepard (1995) used a similar approach by using a preliminary workshop to introduce teachers to classroom assessment after which they met biweekly to discuss aspects such as making observations, analyzing students' work, developing assessment rubrics. Through these ongoing discussions the teachers became more capable of organizing and assessing hands-on, problem-based, group activities. The teachers were also able to acquire more sophistication in developing and using scoring criteria with their students.

Jones and Moreland (2005) aimed at changing teachers' formative assessment practices by enhancing their pedagogical content knowledge in a New Zealand primary school. This involved teachers reflecting on their practices or those of others and using planning frameworks. They also attended workshops and teacher meetings. They were provided with classroom support and taught how to use student portfolios and doing summative profiling. The impact of this professional development initiative on teachers' formative assessment practices and student learning was very significant. As such
changes were made to classroom practices at the level of the whole school, and were also incorporated effectively into other science programs and curriculum areas.

The approaches described above all have some aspects of knowledge base professional development in that they draw from teachers’ shared knowledge base to improve practice. Lesson study, originating from Japan, is a common type of knowledge base professional development. This is a professional development process during which teachers systematically examine their practice, with the goal of becoming more effective (Chokski, 2002). Figure 9 summarizes the lesson study process.

Figure 9: Lesson Study Process (Lewis, Perry & Murata, 2006)
A group of teachers study the curriculum and select an area of interest with specific goals in mind. They plan a lesson which is taught by one of them as they others observe and collect the research data. This is usually followed by a post-lesson colloquium during which the teachers reflect on the collected data and decide on how to improve the lesson. They agree on the improvements, re-teach and document the lesson. This constitutes a complete lesson study cycle. In this study aspects of lesson study will used as two groups of chemistry teachers reflect on and improve their formative assessment skills.

Conclusion

Formative assessment holds a lot of promise for student learning in science. Though different models may exist, its common features involve collecting information about student learning and using this information to improve student learning. That is what makes it distinct from summative assessment. Despite the agreement on the importance of formative assessment teachers do not generally use this strategy. Many obstacles account for this, most prominent of which, is the lack of the skills needed for its implementation.

Professional development, requiring teachers to play an active role, could be interspersed with classroom practice as the teachers work in groups to improve their formative assessment practice (Kennedy, 1999). Such collaborative approaches used by groups of teachers, could be an effective professional development strategy if the teachers practice it over extended periods of time. Literature provides many different approaches as described above. Groups of teachers with the help of experts could use a lesson study-styled approach to improve on their formative assessment practices.
CHAPTER III

METHODOLOGY

Introduction

This chapter presents the procedures used in the study. The chapter starts by explaining the rationale for the qualitative research strategy as well as the specific research method used in the study. This is followed by a description of the participant selection and an elaboration of the research protocol.

Research Paradigm and Methodology

By studying teachers' views and practices with respect to formative assessment in their own classrooms, the study falls within the confines of the interpretivists paradigm. Interpretivists aim at doing research within a "natural setting" (Williamson et. al, 2002, p. 10) by interpreting the meaning that individuals attach to their actions (Schwandt, 1994). Darke et. al (1998) states that the interpretive approach is based on the "ontology in which reality is subjective, a social product constructed and interpreted by humans as social actors according to their beliefs and value systems" (p. 276). The results of the study, therefore, depend on the researcher's interpretation as he "watches, listens, asks, records, and examines" (Schwandt, 1994, p. 119). Interpretivists, therefore, seek to understand "the complex world of lived experiences from the point of view of those who live it" and are more concerned with "matters of knowing and being" than with methods and so adopt a variety of field practices in doing their work (Schwandt, 1994, p. 118). An important aspect of interpretivist inquiry, according to Williamson et. al (2002), is that it
does not attempt to generalize findings but rather seeks transferability, which ties with the significance of this study in that it will provide an opportunity for the findings of the study to be applied to other settings. As such, teachers' experiences with formative assessment could be extended to other areas of the science curriculum and just chemistry as is the case with this study.

The case study methodology was chosen for this study. Yin (1994) describes a case study as “an empirical inquiry that investigates a contemporary phenomenon within its real life context, especially when the boundaries between phenomenon and context are not clearly evident” and “in which multiple sources of evidence are used” (p. 13). Stake (1994) emphasizes the need to “optimize understanding of the case rather than generalization beyond” (p. 236). This study explores teachers' formative assessment views and practices within their classrooms, providing an in-depth description of the strategies they use as they are introduced to formative assessment though professional development. The case study method was chosen for the study as it carefully examines a contemporary issue (teachers’ use of formative assessment strategies), within real life settings (their everyday classrooms), using multiple data collection methods (questionnaires, participant observations, interviews and discussions, and written reflections). This study involves a single case of chemistry teachers as they undergo professional development intervention in the use of formative assessment.

Study Participants

Twenty-eight science teachers from the two main cosmopolitan areas of Anglophone Cameroon (Bamenda and Buea areas) were involved in the first part of the
study. These two areas were chosen for logistical reasons since they were easily accessible. Fifty questionnaires were randomly sent out to teachers in secondary schools in the two areas. Information was not sought about the number of science teachers in a given school before sending the questionnaires. Random selection was used because the intention was to obtain a broad picture of teachers' assessments views in Anglophone Cameroon. These teachers completed a short questionnaire of five questions (Appendix D) on their assessment practices. Twenty-eight completed questionnaires were returned. The sampling, obtaining of consent, and administering of the questionnaire was done by a research liaison in Cameroon. This person had good research skills and was involved in constant discussions with the researcher.

The remainder of the study involved eight other teachers from the Bamenda area. The eight chemistry teachers were selected from four schools within a 20 km radius of Bamenda. Selection of participants from within a 20 km radius was to ease the functioning of lesson planning and implementation groups. The researcher's relationship with the school administrators as well as the administrators' support for the study was also important in choosing the four school as it was to ensure a smooth running of the research activities, especially, when it came to issues such as timetable alterations and equipment use. Purposive sampling was employed in selecting the final eight teachers in order to obtain participants who would provide an opportunity for the researcher to learn about the phenomenon (Stake, 1994) of formative assessment. For this reason, participants were selected based on their willingness to participate in the study. They also had to have at least some involvement in chemistry teaching as the lesson planning and implementation was to be in chemistry. This part of participant selection was done by the
researcher who contacted the administrators, and then the teachers. One of the schools seemed very relevant to the study as it had extremely large classrooms, very enthusiastic teachers and administration and therefore, provided four out of the eight participants of the study. The rest of the four participants were selected from the other three schools. These eight participants proceeded to take part in the rest of the study.

Research Procedure

Table 6 summarizes the different stages of the data collection procedure.

Table 6

Summary of Data Collection Procedure

<table>
<thead>
<tr>
<th>Phase</th>
<th>Activity</th>
<th>Data collected</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Questionnaire</td>
<td>Teachers' beliefs and knowledge of formative assessment.</td>
<td>3 weeks</td>
</tr>
<tr>
<td></td>
<td>Group discussion</td>
<td>Teachers' formative assessment views and knowledge</td>
<td>1 hour</td>
</tr>
<tr>
<td></td>
<td>Initial lesson</td>
<td>Teachers' formative assessment practice</td>
<td>2 weeks</td>
</tr>
<tr>
<td></td>
<td>observations Individual</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>teacher interviews</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Orientation workshop</td>
<td>Teachers' views, knowledge and changes</td>
<td>1 day</td>
</tr>
<tr>
<td>2.</td>
<td>Research lessons</td>
<td>Teachers' change in practice</td>
<td>3 weeks</td>
</tr>
<tr>
<td></td>
<td>Post lesson discussions</td>
<td>Teachers' change in views and knowledge</td>
<td>per group</td>
</tr>
<tr>
<td></td>
<td>Group Reflections &amp; Reports</td>
<td>Teachers' change in views and knowledge</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Final Reflections</td>
<td>Teachers' final thoughts: wishes, apprehensions, needs, etc.</td>
<td>2 days</td>
</tr>
<tr>
<td></td>
<td>Final Discussions</td>
<td></td>
<td>1 hour</td>
</tr>
<tr>
<td>3.</td>
<td>Follow-Up Study</td>
<td>Long-term changes</td>
<td>6 weeks</td>
</tr>
</tbody>
</table>
**Questionnaire**

The data collection process commenced with the initial 28 teachers filling an open-ended questionnaire (Appendix D) which provided information about science teachers' assessment views and practices. This information served as preliminary data which provided a broad understanding of the teachers’ assessment views and practices.

**Group Discussion**

The final eight participants took part in a group discussion on assessment. This was used to expand or triangulate the data collected from the questionnaire and provide a basis for focusing on the eight participants’ beliefs and knowledge of assessment. A group discussion was chosen to save time and allow for a diverse and critical exchange among the participants. This allowed for deep exploration of the various aspects of classroom assessment because of the teachers’ shared experiences and concerns (Fossey et. al (2002) and were therefore able to feel comfortable during the discussion. The questions on Appendix D guided the discussion which was facilitated by the researcher. The group discussion was audio taped.

**Lesson Observation and Interviews**

The eight participants were observed teaching at least two lessons in their regular classrooms over a period of three weeks. The observations focused on the teachers’ assessment practices. Observation of the participants was useful in that it provided an opening to obtain an intense understanding of the participants’ assessment routines, practices, and interactions (Fossey et. al (2002) with students. This involved noting the
role of (formative) assessment in their classrooms, how they gathered information about students’ learning, how they used the gathered information, as well as the types of feedback, and the role that students played in the assessment process (Table 7). These categories were based on the important aspects of the formative assessment cycle (Figure 3). These aspects formed the guiding principles throughout the study. Field notes were taken on how each of these aspects prevailed in the lessons taught by the eight teachers. Each class had a duration of fifty minutes and meet twice a week.

### Table 7

**Data Collected**

<table>
<thead>
<tr>
<th>Data Category</th>
<th>Detail Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>1   Use of formative assessment cycle</td>
<td>- Any evidence of use of formative assessment cycle?</td>
</tr>
<tr>
<td></td>
<td>- How do they implement different aspects of the formative assessment cycle?</td>
</tr>
<tr>
<td>2   Gathering of information about student learning</td>
<td>- What information is gathered about student learning?</td>
</tr>
<tr>
<td></td>
<td>- How is the information collected?</td>
</tr>
<tr>
<td></td>
<td>- What is done with the information collected?</td>
</tr>
<tr>
<td>3   Giving feedback</td>
<td>- Is there any feedback to students?</td>
</tr>
<tr>
<td></td>
<td>- What types of feedback are used?</td>
</tr>
<tr>
<td></td>
<td>- How prompt is the feedback?</td>
</tr>
<tr>
<td>4   Student role</td>
<td>- Do students play any role?</td>
</tr>
<tr>
<td></td>
<td>- Is there self or peer assessment?</td>
</tr>
</tbody>
</table>

Each teacher was engaged in an open-ended, individual interview by the end of the day of the second lesson. These interviews lasted between thirty and forty-five
minutes and focused on the teachers’ assessment practices during the observed lesson. The interviews focused on themes extracted from the notes taken during lesson observations with emphases on the study aspects mentioned earlier (the role of assessment in students’ learning, the process of gathering information about students’ learning, feedback type and the students’ role - Table 7). During the interviews, reference was made to particular practices, occurrences, or routines observed during the lessons as concerns the teachers’ assessment practices. The interviews provided insights into the teachers’ views about assessment and corroborated or contradicted the data collected from the group discussions and observed lessons, and also helped determine if there were any common themes in the participants’ views and practices. The interviews were also audio taped.

**Assessment Workshop**

The eight participants took part in a one-day workshop on formative assessment which was facilitated by the researcher who had previous experience running such workshops as science educator in Cameroon. The Institute for Inquiry’s (2006) workshop guidelines on formative assessment was used. This set of 5 workshops, based on the work of noted British educator, Wynne Harlen, introduces the Formative Assessment Cycle (Figure 3), and helps participants develop a comprehensive view of formative assessment in the classroom. Workshop I, “Introduction to Formative Assessment”, introduces participants to the purposes of formative assessment and how it differs from summative assessment. In Workshop II, “Assessing Process Skills”, participants learn how to observe and interpret students’ process skills in science. Workshop III, “Effective
Questioning”, helps participants identify questions that are useful in eliciting student ideas. Workshop IV is titled “Assessing Science Ideas” and in this workshop participants create indicators of development for specific scientific ideas and consider the nature of feedback that helps student learning. The last workshop, “Student Self-Assessment”, investigates the value of students assessing their work and that of their peers. Complete guidelines on the facilitation of these workshops are found at http://www.exploratorium.edu/IFI/workshops/assessing/index.html.

In the case of this one-day assessment workshop, only Workshops I, III and IV were done in their entirety. Parts of Workshop II and Workshop V were incorporated in the discussions ensuing from Workshop III and IV. Figure 10 is an outline of Formative Assessment Workshop. In Part I (of Figure 10), the participants were presented with four classroom vignettes (Appendix E) on assessment which they studied in 4 groups and then went ahead to complete the classroom assessment vignettes grid (Appendix F). This activity helped the participants express their different views about assessment which were collected and discussed during a whole group discussion. After this the facilitator presented the formative assessment cycle (Figure 3) which was discussed and compared to summative assessment (Figure 4). This section of the workshop ended with the facilitator summarizing some main points from formative assessment research findings.

In Part II of the workshop, the participants were presented with the hinged mirrors and floating eggs activities (Appendix G) from which they each wrote one question from each activity that they would have asked their students if these activities were done in class. After giving the participants time to discuss the questions in their groups, the facilitator collected the questions under four columns (subject-centered, process-centered,
Part I: Introduction to Formative Assessment (2 hours)

- Classroom Vignettes Activity
- Formative Assessment Cycle
- Summary of Research Findings

Part II: Effective Questioning (2 hours)

- Writing and Analyzing Questions
- Examining Questioning in Practice

Part III: Assessing Students' Ideas in Science (3 hours)

- Finding Evidence of Ideas
- Generic and Specific Indicators
- Providing Student Feedback

Figure 10: Outline of Formative Assessment Workshop

person-centered and “other” types of questions), without indicating the heading of each column. It is only after a discussion of what the questions in each column have in common that the facilitator gave the names for each category of questions. This was followed by the facilitators using some of the questions from the participants to state and explain open and closed questions. This segment of the workshop on questioning ended
with a discussion on different aspects related to questioning such as the use of “wait
time”, responding to students’ answers, and how to use questioning to reveal students’
process skills.

The last part of the Workshop built on the previous one on questioning. In this
part, the participants learned how to find evidence of students’ thinking or learning from
their work. The participants were presented with three work samples from 3 different
students on how sound is produced (Appendix H) and shown how to use generic
indicators (Appendix I) to interpret students’ work. They were then presented with
another student’s work sample on the adaptation of crayfish to its habitat (Appendix J)
and an Assessing Ideas Activity Sheet (Appendix K) to situate the students’ level and
then translate the generic indicators into specific ones. The next part of Workshop IV
involves the participants using the crayfish work sample to provide feedback to this
student (Appendix L) which then led to a whole group discussion on various aspects of
feedback such judgmental and nonjudgmental feedback, comments only feedback and
involvement of students in peer and self-assessment (Appendix M).

At the end of the workshop the participants were given extra material which they
could study on their own. The idea was to introduce the participants to formative
assessment and give them the opportunity to personally reflect and develop their
formative assessment views and practices during the planning and teaching of the
research lessons. Also, at the end of the workshop the participants split into two groups.
They began to discuss and plan the lessons they were going to teach.
Lesson Planning and Implementation Process

Table 8 is a summary of the lesson planning and implementation process. The procedure used aspects of the lesson study process which was described in Chapter 2.

Table 8
Summary of Lesson Planning and Implementation Process

<table>
<thead>
<tr>
<th>Time</th>
<th>Duration</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Week One</td>
<td>4 days</td>
<td>• Teachers study schemes of work</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Teachers decide on goals of the lesson</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Teachers plan the lesson/collect material</td>
</tr>
<tr>
<td>Week Two</td>
<td>1 day</td>
<td>• Teachers teach lesson</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Lesson observation 1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Post-lesson discussion 1</td>
</tr>
<tr>
<td>Week 3</td>
<td>2 days</td>
<td>• Revision of lesson</td>
</tr>
<tr>
<td></td>
<td>1 day</td>
<td>• Teachers teach revised lesson</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Post-lesson discussion 2</td>
</tr>
<tr>
<td></td>
<td>3 days</td>
<td>• Writing of reflection and lesson reports</td>
</tr>
</tbody>
</table>

Each of the two groups formed by the participants studied the chemistry schemes of work (the equivalent of benchmarks) and chose a topic from which they were to teach the research lesson. In addition to the already defined goals in the schemes of work, the teachers of each sub-group were asked to place special emphases on the incorporation of lots of formative assessment aspects in the lessons. This entailed incorporating all the ideas from the orientation workshop and extra literature which was provided. Each group without any input from the researcher, planned the chosen lessons and submitted a copy of the lesson plan to the researcher. They were expected to make explicit how they will
gather information about student learning in their plans. One member of the group taught the lesson while the rest of the group members, together with the researcher and the members of the second group, observed and took notes.

The teacher teaching the lesson did so in a class he usually teaches. Each observer was reminded of the type of information they were to look for (Table 7). Each observer was expected to identify the strengths and weaknesses of the formative assessment aspects of the lesson.

At the end of the day, all the participants and the researcher came together in a post-lesson discussion about the extent to which formative assessment practices were incorporated in the lesson, and how it could affect student learning. The researcher moderated the discussions. The group which planned the lesson first gave their impression on how they thought the lesson went. The other group members then made comments and gave suggestions on how the lesson could be improved. Every observer was encouraged to actively take part in the discussions. The discussion focused on the agreed-upon aspects of formative assessment (Table 7). The research lesson was videotaped and post-lesson discussion was audio taped.

After this, the group used the ideas from the post-lesson discussion to revise and re-teach the lesson the following week. The re-teaching of the lesson took place in a different classroom but with students of similar age and level and was taught by the same teacher. It was also observed by the other participants and the researcher. This was followed by an end-of-lesson-cycle discussion which also audio taped. After this, the group submitted the improved lesson plan and a group reflection about the whole process.
through reflective thinking and summarize all their thoughts into the group reflection. The teachers were reminded to use Table 7 as a guide and to note any successes and constraints in their use of formative assessment when writing their reflections.

The planning, teaching, post lesson discussions and re-teaching ran for three weeks for each group. This means a total of six weeks was used for the two groups. At the end of the six weeks, each participant wrote an individual reflection report on the whole process. The participants were asked to emphasize the knowledge and skills they acquired as concerns formative assessment. The participants were also asked to point the difficulties they envisaged as well as the types of support they would need if they choose to engage in formative assessment in future.

**Follow-up Study**

Each teacher prepared and submitted a lesson plan of a lesson they were going to teach the following term. Each teacher was given one week to reflect, choose and plan a lesson from the schemes of work for the next term. During the next term, which started in September 2008, they taught these lessons which were video-taped or observed and detailed notes taken by watching the videos or observing the lessons directly by the researcher. The aim was to see how the teachers individually used the different aspects of formative assessments. Each teacher was asked to write a short reflection on how the principles of formative assessment were implemented in the lesson. These reflections were guided by the four points as shown on Appendix K.
Data Analysis

Questionnaire

Data from the questionnaire was studied to extract the main themes for the four main data categories (evidence of formative assessment, collection and use of the assessment information, feedback and role of students in the assessment process). Tables were used to show the different responses and their frequencies. The teachers' responses were placed within each of the four main categories and then the number of people counted for each response. This information provided general but important preliminary data on science teachers' views and knowledge about assessment which helped in situating where the teachers were in terms of formative assessment and charted the rest of the study.

Group Discussion, Lesson Observations, and Individual Interviews

The transcripts from the group discussions, notes from the lesson observations as well as the transcripts from the individual interviews were carefully read, sections underlined and notes made on the margins. Key ideas and recurrent themes (Pope, Ziebland & Mays, 2007) as concerns the use of assessment strategies were identified and tabulated under the four main preconceived categories. The use of the four main categories was aimed at limiting the scope of the data collection. However, any relevant aspects which arose, and did not fit into any of the four categories, were treated under the first category of formative assessment cycle. With the data in categories, the different categories were carefully studied to take note of some "important" declarations (prominent points or arguments the participants make), omissions (what they fail to say
or do), or the frequency (LeCompte, 2000) of some practices especially in the case of the lessons observed. The next step was to look for patterns from the group discussion, through the observed lessons, to the interviews as concerns the four main assessment categories. This meant looking for similarities, sequences, or corroboration (LeCompte, 2000) in the group discussion, lesson observation notes, and individual interviews. This provided an overall description of the participants' initial views' and practices as concerns assessment (Research Question 1). This also provides an idea of the relation between the teachers' beliefs and knowledge about assessment, and their practices.

**Assessment Workshop**

Transcripts of participants' work from the different activities during the workshop (classroom vignette activity, hinged mirrors and floating eggs activity, assessing student ideas activity, and effective feedback activity) were analyzed for frequency of ideas presented as well omissions about assessment. These provided more triangulation on the teachers' views and knowledge about assessment.

At the end of the workshop the participants were asked to write a reflection on the workshop ideas as related to formative assessment. They reflected on the formative assessment cycle and its uses, aspects they would use as well as anticipated difficulties and support needed. Their reactions, opinions and apprehensions as concerns the use of formative assessment practices in their classrooms were drawn from the reflections. The data from the workshop reflections were presented in tables and crosschecked to identify any changes in the teachers' views and knowledge about assessment in general and formative assessment in particular. This served a beginning point in identifying any
changes in views, areas of resistance, fears or optimism on the part of the eight participants (Research Question 2 & 3).

Research Lessons, Post Lesson Discussions, and Reflections

Notes from lesson observations, transcripts of post-lesson discussions, and the reflections of each of the groups were read and again themes were developed and placed into the already known categories. The information was placed in tables alongside their frequencies. This helped in showing the participants' enthusiasm, apprehensions, anticipated difficulties and support as they reflected on the use of formative assessment in their classrooms. A comparison was employed from one stage of the process to the other (from the first lesson and the post-lesson lesson discussion, through the second lesson and discussion to the reflections). These involved making comparisons between the main themes as they planned taught and reflected on the research lessons. Quotes and narratives from the participants' reflections were also used in the presentation of the data. This gave an indication of their shifts in views and practice with respect to formative assessment (Research Question 2).

Themes from the final reflections and discussions were used to determine the participants' final views about formative assessment. Their overall feelings of each participant were determined by carefully studying the reflections and transcripts of the final discussion. Their thoughts and needs in terms of expertise, administrative and logistical support was also extracted for the data (Research Question 2 & 3).
Follow-up Study (Lesson Plans, Implementation, and Reflections)

The lesson plans from each teacher were carefully read for explicit elaboration of the lesson objectives and specific formative assessment strategies to be used in the lessons. The taught lessons were equally checked with respect to the four points guiding the studies (Table 7). The responses to the reflection questions (Appendix K) were also studied. A comparison of themes from the lesson plans through the reflections was done for each teacher for consistency of views and practice. Another important comparison done was with the teachers’ present views and practice with the initial ones at the beginning of the study. This provided more triangulation of the data to show the changes by the teachers (Research Question 2)

<table>
<thead>
<tr>
<th>Phase I</th>
<th>Phase II</th>
<th>Phase III</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-Workshop Activities</td>
<td>Lesson Planning &amp; Implementation</td>
<td>Follow Up</td>
</tr>
<tr>
<td>• Questionnaire</td>
<td>• Lesson Observations</td>
<td>• Lesson Plans</td>
</tr>
<tr>
<td>• Group Discussion</td>
<td>• Post-Lesson Discussions</td>
<td>• Lesson Observations</td>
</tr>
<tr>
<td>• Lesson Observations</td>
<td>• Reflections</td>
<td>• Reflections</td>
</tr>
<tr>
<td>• Interviews</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 11: Summary of Data Collection and Analysis
CHAPTER IV

FINDINGS

Introduction

This chapter presents the findings from the different phases of the study. This information is presented in three sections: pre-workshop/workshop phase; lesson planning and implementation phase; and the follow-up phase. The first phase comprises the assessment questionnaires for 28 science teachers, group discussion on assessment, lesson observations, individual interviews, and the assessment workshop for a smaller group of eight teachers. This first phase provides information about the participants' initial assessment views and practices which is used to answer research question 1 and parts of questions 2 and 3. The second phase involves the lesson planning and implementation process. Lesson plans from two teaching groups (formed by the final eight participants), group discussions and reflections yield part of the information to answer research question 2 and 3. Phase III involved individual teachers planning and teaching a lesson with various aspects of formative assessment on their own. The lesson plans, lesson observations, and reflections provided information which is used to triangulate and consolidate the answers to research question 2.

Assessment Questionnaire: Teachers’ Views of Assessment

A questionnaire was administered to 28 teachers to identify their general views about assessment. This involved finding out the teachers’ views about the different methods of assessment, the use of assessment information, role and use of feedback, and
students' role in the assessment process. Table 9 presents the different themes which
summarize the variety of assessment methods (oral questioning, quizzes, tests,
examinations and homework) indicated by the teachers and the percentage of teachers
who indicated they used it. These statements are simply written responses to the
questionnaire prompts. The percentages indicate the percentage of teachers who indicated
that they used a particular assessment method. The actual percentage of teachers who use
each method may be different in some cases e.g. it is certain that all teachers administer
examinations.

<table>
<thead>
<tr>
<th>Methods of Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assessment Method</td>
</tr>
<tr>
<td>1. Oral questioning</td>
</tr>
<tr>
<td>2. Administering tests</td>
</tr>
<tr>
<td>3. Assigning homework</td>
</tr>
<tr>
<td>4. Administering quizzes</td>
</tr>
<tr>
<td>5. Administering examinations</td>
</tr>
<tr>
<td>6. Class activities and exercises</td>
</tr>
</tbody>
</table>

Though the teachers indicate using assessment methods from all three categories of
assessments (paper and pencil, performance, and personal communication), it seems this is
dominated by oral questioning and various forms of written assessments. According to
literature (e.g. Stiggins, 1992), paper and pencil assessment play a valuable role in
assessments, but so do performance assessments (assessments of process skills) and
various forms of personal communication with students, which can help assess attitudes.
The teachers surveyed did not mention the use of methods such observation of students,
use of reflective journals, and student self evaluation, as important assessment methods. If teachers do not use these proven types of assessment, they may fail to gather a complete picture of student learning. Some teachers went as far as mentioning the type of paper and pencil tests and examinations such as multiple choice, structural and essay questions, which they administered to the students. As these are the types of questions which are often used in standard national examinations, it seems the teachers focus on them so as to get the students acquainted to these examinations rather than focusing on student understanding.

Most of the teachers (85.7%) indicated that they use oral questioning which may suggest that this is the most popular assessment method. Some of the teachers emphasized that they engage in oral questioning more at the beginning and end of each lesson indicating they hold the view that classroom assessment are to be done at particular times. Using oral questioning to find out students' ideas at the start of a lesson topic may indicate that the teachers attach importance to the assessment of students prior knowledge while using it at the end of the lesson may indicate that it is being used in checking for student understanding. Some of the teachers who administered quizzes noted that they did so almost on a weekly basis while some said they did so at the end of each topic. The responses showed that tests were administered on a frequency between every two and every six weeks while examinations (big tests) were generally administered at the end of the term or end of the year. The assigning of homework varied from daily to monthly. Apart from oral questioning the teachers' responses showed that assessment is a routine activity done at particular time intervals or after covering a certain amount of content. This may have been influenced by the commonly held view that
assessment does take place at predetermined times rather than at all times during the instruction process. This is a common practice in many schools as there are assessment dates scheduled by the administration. This is usually in the form of major tests which come up after six week durations. The school year is generally divided into five assessment periods at intervals of six weeks, each period being known as a sequence. During each testing period, teaching is halted to get students effectively involved in these tests. The grades from these five major tests are used on the students’ report cards.

Collection and Use of Assessment Information

Table 10 shows the categories of assessment information that the teachers collect. The table shows that most of the teachers are conscious of the fact that using assessment to obtain information about student is important. It can also be seen that the teachers get an indication of how they teach from the assessments. The responses indicate that the teachers’ use of the assessment process to collect other information about students’ learning places more emphases on the cognitive domain. A small number of teachers feel they can use the assessment to find out students’ attitudes, which, is very important in that it could give an idea of the students willingness to collect and use evidence, critically review procedures, and change ideas in the light of the evidence they have (Harlen, 2003). The responses do not indicate that the teachers are aware of the use of assessment to collect information about students’ process skills such as raising questions, planning and carrying out investigations, observing, interpreting and communicating the results. This is further evidence that the teachers’ use mostly paper and pencil methods of
assessment. Table 11 summarizes the different uses of the assessment information as indicated by the teachers.

### Table 10
Information Collected

<table>
<thead>
<tr>
<th>Information categories</th>
<th>Themes of assessment information collected</th>
<th>%</th>
<th>Sample questionnaire responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student learning</td>
<td>Level of student understanding/comprehension</td>
<td>71.4</td>
<td>‘The information I gather gives me the prior knowledge they (students) have about an idea or concept. It reveals to me their ignorance or weakness, or what they have understood and how they can apply it where necessary’.</td>
</tr>
<tr>
<td></td>
<td>Areas of difficulties</td>
<td>39.3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Students who study and those who do not study</td>
<td>25.0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Students’ misconceptions</td>
<td>10.7</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Students’ previous knowledge of topic</td>
<td>7.1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Degree of attainment of lesson objectives</td>
<td>7.1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Students’ presentation skills</td>
<td>7.1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Students’ improvement</td>
<td>3.6</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Students’ strengths and weaknesses</td>
<td>3.6</td>
<td></td>
</tr>
<tr>
<td>Student attitudes</td>
<td>Students’ attitudes and impressions of subject</td>
<td>3.6</td>
<td>‘Assessments give me the students’ impression of the subject I teach’.</td>
</tr>
<tr>
<td></td>
<td>Students’ self confidence</td>
<td>3.6</td>
<td></td>
</tr>
<tr>
<td>Teacher activities</td>
<td>Teachers’ performance</td>
<td>14.3</td>
<td>‘Student assessment helps me know if the lesson was well taught or not’.</td>
</tr>
<tr>
<td></td>
<td>Limitations of different testing methods</td>
<td>7.1</td>
<td></td>
</tr>
</tbody>
</table>

Other uses of assessment information mentioned included improving communication and collaboration among students which could lead to increased metacognition skills and ability to assess their progress as well as that of their peers.
Table 11

Use of Assessment Information

<table>
<thead>
<tr>
<th>Assessment Use</th>
<th>Themes of Assessment Information Use</th>
<th>%</th>
<th>Sample Questionnaire Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>To improve student learning</td>
<td>Encourage or counsel</td>
<td>25.0</td>
<td>‘It helps me repeat certain concepts that the assessment proves the student do not assimilate’.</td>
</tr>
<tr>
<td></td>
<td>Re-teach areas of difficulty students</td>
<td>21.4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Put more emphases and time on certain areas</td>
<td>17.9</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Provide more drilling to the students</td>
<td>7.1</td>
<td></td>
</tr>
<tr>
<td>To improve teaching</td>
<td>Rethink and modify teaching strategies</td>
<td>67.9</td>
<td>‘The information helps me to update my teaching materials and to improve my teaching methods’.</td>
</tr>
<tr>
<td></td>
<td>Improve assessment methods</td>
<td>17.9</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Guide lesson planning</td>
<td>7.1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Update teaching resources</td>
<td>3.6</td>
<td></td>
</tr>
<tr>
<td>Enhance collaboration among students</td>
<td>Pair weak students with strong ones for assistance</td>
<td>7.1</td>
<td>‘I link the weak students with the strong ones and do some follow up on them to ensure that they pick up’.</td>
</tr>
<tr>
<td>Classify students</td>
<td>Distinguish weak students from strong ones</td>
<td>3.6</td>
<td>‘The information helps in classifying the students as required by the administration. Sometimes the students are given prizes based on this information’.</td>
</tr>
<tr>
<td></td>
<td>Prepare grades for administrative purposes</td>
<td>3.6</td>
<td></td>
</tr>
</tbody>
</table>

(Angelo, 1998). Having a small number of teacher responses indicating that assessment information could be used to enhance collaboration among students could indicate that most teachers place little emphases on aspects related to self and peer assessment.
Teacher Feedback

Table 12 categorizes the different types of feedback mentioned by the teachers using Tunstall & Gipps' (1996) classification.

Table 12
Feedback Type

<table>
<thead>
<tr>
<th>Feedback Categories</th>
<th>Themes from Teacher Responses</th>
<th>%</th>
<th>Sample questionnaire responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constructing achievement/way forward</td>
<td>Guidance and strategies on how to study</td>
<td>10.7</td>
<td>'I recommend the students to follow methods they find useful or stop the continuation of approaches if found less useful or useless'.</td>
</tr>
<tr>
<td></td>
<td>Provide follow up activities</td>
<td>3.6</td>
<td></td>
</tr>
<tr>
<td>Specifying attainment/Achievement</td>
<td>Correction of tests and assignments after marking</td>
<td>28.6</td>
<td>'I inform them where they did well or where they fell short of the target. When I return the scripts, we take stock of the favorable aspects and the points/questions that were poorly attempted. I give information that was not exhausted in their groups'.</td>
</tr>
<tr>
<td></td>
<td>Point out students' errors and poorly attempted aspects</td>
<td>25.0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Point out favorable aspects and successes</td>
<td>10.7</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Write the students answers on board</td>
<td>3.6</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Indicate information they left out</td>
<td>3.6</td>
<td></td>
</tr>
<tr>
<td>Approving/disapproving</td>
<td>Congratulate strong students and encourage weak ones</td>
<td>10.7</td>
<td>'The feedback given to students is encouragement – advice and congratulations in view of how to improve the performances after correction and distribution of copies'.</td>
</tr>
<tr>
<td></td>
<td>Positive and negative feedback</td>
<td>3.6</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Provide reinforcement</td>
<td>3.6</td>
<td></td>
</tr>
<tr>
<td>Rewarding/Punishing</td>
<td>Punish the lazy students</td>
<td>3.6</td>
<td>'Identify lazy students who do not pay attention in class and punish them'.</td>
</tr>
</tbody>
</table>
The responses show that the teachers are generally aware that assessment information is used to improve on student learning and the teaching process. The themes indicate that the teachers’ offer corrective instruction to remedy students learning errors (Guskey, 2003). However, a closer look at the themes related to the improvement of learning on the table raises questions as to whether this involves high-quality, corrective instruction whereby the teacher plans and uses instructional alternatives that present the initially studied concepts in “ways that engage students in different and more appropriate learning experiences” (Guskey, 2003, p. 3) or that this is just an issue of more drilling and restating of the of the original ideas. Further triangulation would be needed to clarify this aspect. The teachers also stated that the information is used for administrative purposes especially as the system is one which involves high-stakes testing. There is the classification or ranking of students with the strong students often rewarded and the weak one punished. One of the responses on the use of the assessment information even stated, “I use the information to identify lazy students who do not pay attention in class and punish them”.

The results on the Table 12 indicate that most of the feedback the teachers give fall in the category of specifying achievement and attainment (71.5%). This shows that, though, most of the feedback is descriptive, it does not offer hints and direction to the students on how to improve their work. A small percentage of teachers (10.7% and 3.6%) indicated that they use descriptive feedback that provides students with ways of moving forward and improving their learning. This percentage is actually less than the category of teachers who offer evaluative feedback by approving and disapproving of students’ work. Just one teacher (3.6%) admitted to punishing as feedback. It would be important to
compare this with practice to see if the teachers' beliefs actually reflect their practice. Overall, it can be seen from the teachers' responses that feedback mainly consists of identifying right and wrong answers at the end of class activities and various assessment activities and throwing of praise in the case of right answers or reprimanding wrong answers as reported by Shepard (2001, 2005). The teachers generally stated they will provide the feedback for the students' work immediately after they have finished looking at it. In one case the respondent specified that this is usually done within a week of the students submitting their work to the teacher.

Student Involvement in the Assessment Process

The teachers who acknowledged involving students in various group activities for the purpose of assessment were able to mention some of these activities. Table 13 lists the different types of activities specifically mentioned by the teachers.

Table 13

<table>
<thead>
<tr>
<th>Student Activities</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discussions</td>
<td>35.7</td>
</tr>
<tr>
<td>Experimentation/Investigations</td>
<td>25.0</td>
</tr>
<tr>
<td>Going to the blackboard</td>
<td>17.9</td>
</tr>
<tr>
<td>Presentations</td>
<td>14.3</td>
</tr>
<tr>
<td>Demonstrations</td>
<td>10.7</td>
</tr>
<tr>
<td>Role-plays</td>
<td>3.6</td>
</tr>
</tbody>
</table>
These are activities that most likely require students to engage in group work. Overall, 64.3% of the teachers said they used one form of group activity at one moment or another and of this percentage, 7.1% said they engage students in group work infrequently. The reason they gave for not using group work regularly is that it is time consuming and difficult to manage which are common fears among inexperienced teachers.

The Final Eight Participants of the Study

Table 14 lists the final 8 participants of the study and some important information about each of them. The names used are not their real names.

<table>
<thead>
<tr>
<th>Name</th>
<th>Age</th>
<th>Qualification</th>
<th>Years teaching</th>
<th>Subject(s) currently teaching</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nathan</td>
<td>30</td>
<td>B.S. in chemistry, Advanced Teachers' Diploma</td>
<td>3</td>
<td>chemistry</td>
</tr>
<tr>
<td>Martha</td>
<td>35</td>
<td>B.S. in mathematics education</td>
<td>10</td>
<td>biology and chemistry</td>
</tr>
<tr>
<td>Tim</td>
<td>26</td>
<td>B.S. in physics</td>
<td>3</td>
<td>physics, chemistry and mathematics</td>
</tr>
<tr>
<td>Paul</td>
<td>25</td>
<td>B.S. in chemistry education</td>
<td>2</td>
<td>Chemistry</td>
</tr>
<tr>
<td>Fiona</td>
<td>24</td>
<td>B.S. in biochemistry</td>
<td>1</td>
<td>biology and chemistry</td>
</tr>
<tr>
<td>Daniel</td>
<td>42</td>
<td>B.S. in biology</td>
<td>18</td>
<td>biology and chemistry</td>
</tr>
<tr>
<td>Annabel</td>
<td>25</td>
<td>B.S. in physics education.</td>
<td>2</td>
<td>physical science and physics</td>
</tr>
<tr>
<td>Lucas</td>
<td>30</td>
<td>B.S. in botany</td>
<td>5</td>
<td>biology and chemistry</td>
</tr>
</tbody>
</table>
Four of the eight teachers (Nathan, Martha, Paul and Annabel) hold teaching certificates. Nathan is a 30 old year teacher of chemistry with 3 years of teaching experience. He holds a B.S. in chemistry and an Advanced Teachers’ Diploma (equivalent to MS). Martha is 35 years old and holds a bachelor in mathematics education. She started off teaching mainly mathematics but with a shortage of chemistry teachers she was asked to teach chemistry. Students thought she did a better job in teaching chemistry so the administration assigned her to teach chemistry and biology. Martha has been teaching for 10 years. Tim is 26 years old and holder of a B.S. in physics with 3 years of teaching to his credit. He teaches physics, chemistry and mathematics. Paul is 25 years, holds a degree in chemistry education and teaches chemistry. He has been teaching for two years. Fiona, 24, holds a B.S. in biochemistry, teaches biology and chemistry, and has been teaching for one year. Daniel is 42 years old and holds a B.S. in biology with 18 years of teaching experience. He teaches biology and chemistry. Annabel, 25, holds a diploma in physics education and has been teaching physical science and physics for two years. Lucas is 30 years old, holder of a B.S. in botany with 5 years of teaching. He teaches biology and chemistry.

**Group Discussion: Teachers’ Views of Assessment**

The 8 teachers were involved in a group discussion about assessment with the researcher as the moderator of the discussion. The discussion focused on the methods of assessment they use in their classes, how they use assessment information, the type and use of feedback, and the roles that students play in the assessment process.
Collection and Use of Assessment Information

Table 15 summarizes the main methods of assessment collected from the group discussion with the 8 participants. Compared to Table 9 from the written interviews with the initial 28 teachers, there was agreement.

<table>
<thead>
<tr>
<th>Assessment Methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Oral questioning by the teacher and students</td>
</tr>
<tr>
<td>2. Assigning and correction of homework</td>
</tr>
<tr>
<td>3. Tests at end of each sequence</td>
</tr>
<tr>
<td>4. Exams at end of term or year</td>
</tr>
<tr>
<td>5. Observation of individual or group work</td>
</tr>
</tbody>
</table>

Apart from the absence of quizzes as one of the assessment methods, all the other approaches are found on both lists. A closer look at the list indicates that there are two main categories of assessment methods: one category over which the teacher has autonomy (oral questioning, assigning of homework and observation of students' work) and another category over which the teachers have little autonomy (tests and examinations). The former involves assessment that teachers use to improve students' learning while the latter is required by the administration and is used for accountability purposes.

Asking the teachers about the methods of assessment that they used indicated that oral questioning was used by all of them. The general idea was that oral questioning is important at the beginning and end of the lesson. The teachers thought that oral
questioning is important at the beginning of the lesson because it helps determine where the students' are with respect to what is to be studied in a particular lesson, which in other words, means the teachers' are checking for students' prior knowledge though it could not be immediately known how the teachers use this prior knowledge in the learning process. The teachers thought oral questioning was important at the end of a lesson because it helps check for understanding which conforms the commonly held view that assessment mostly takes place at the end of learning. However, one of the participants, Paul, thought a few oral questions are important in the middle of the lesson because it provides a connection between the beginning and end of the lesson. Tim also thought having students ask their own questions is very important because it helps the teacher know who has understood and who has difficulties. Though this could serve as good self-assessment technique, it seemed Tim did not see it from this perspective – he said he saw it as another way of knowing who has understood and who has not rather than a way of helping students assess their own understanding.

The teachers all indicated they administer homework. However, two different approaches to how the homework is handled emerged which were largely determined by class size. One group said they give exercises which the students do at home and in the next class they worked through the problems with the students' to get to the correct answers. The other group said they collect the homework, correct it, hand it back to the students, and then do a general correction in class. Correction of students' works by the teacher is by placing ticks on right answers and crosses on wrong ones followed by a summary score which indicates the number of right answers on the particular piece of work. Correction in class will involve mentioning the right answers. When asked about
the frequency of homework and the promptness of the corrections, this second group of teachers responded that it all depended on class size though they agreed it was important to do the corrections in the shortest time possible. Though there was no consensus with respect to the frequency of assigning homework and time limits for returning it, it was unanimous that this depended on the class size. Daniel's response shows this:

**Daniel:** If the number of students is like 60, as prescribed by the Ministry of Education, you can do that regularly, say weekly. In our situation with 300 students per class, that can be done once each term ... *(laughter from the group).*

This is evidence that large class sizes do pose problems for teachers' in the assigning and correction of students' work just as indicated by Kellaghan & Greaney (2003).

All the teachers acknowledged using tests and exams as methods of assessing students. Tests, as stated earlier, are given at particular time intervals, especially at the end of sequences, which are determined by the administration. Examinations as stated by the teachers are usually administered at the end of each of the three terms or just once at the end of the school year in some cases. These tests and exams are mostly summative and are generally used for making decisions on which students get promoted to the next academic level or are awarded certificates. Because of this there is always substantial competition amongst the students which in some cases could lead to students cheating in tests and examinations as indicated by Kellaghan & Greaney (2003).

Observation of students as they engaged in individual, pair or group activities did feature as another assessment method, though the teachers employed it in different ways.
Fiona explained how she gives exercises to students to do in groups and once they have finished doing the exercises one student from each group is chosen to go and present the work of the group on the blackboard. Daniel strongly supports the idea of having students work in groups as it enables the students to develop thinking and brainstorming skills. He also thought group activities keep each student focused and engaged as each of the group member wants to keep up with the rest of the group. However, one member of the group, Paul, though agreeing that observing students as they work in groups can be helpful in giving useful information about their learning, thinks it could transform the classroom into a noisy environment. Paul stated that he would prefer to have the students work individually most of the time as this provides an orderly environment in which he can go round, observe and have an understanding of the different ideas in the class. Paul’s view is stated below:

Paul: I have always reasoned that if I have students work in groups some people might see this as an opportunity for jamborees. I always make them work individually. Then I take the time to go round to find out what they are doing. As a teacher you also learn. Like in balancing equations, there is no standard method but as you move round you will see new ideas of doing this or solving a particular problem. In this case it will help you know what percentage of the class is fine.

There was a difference in opinions as concerns having students working in groups and then observing them as an assessment method, with some of the teachers citing classroom management difficulties as the reason for not engaging students in these types of activities. This is a concern which also emerged from the analysis of the questionnaires (written interviews) as those teachers who said they did not or rarely involved students
cited classroom management difficulties and the lack of time as some of the hindrances to their use of group work.

The variety of ways that the teachers view classroom assessment as being important or how it can be used, as shown in Table 16, closely resembles those obtained from the questionnaires (written interviews).

\[
\text{Table 16}
\]

\begin{tabular}{|l|p{15cm}|}
\hline
\textbf{Category} & \textbf{Use of assessment information} \\
\hline
Student learning & To check for students' understanding of taught material \\
 & To evaluate students' application of learned concepts \\
 & To determine the help that students need \\
 & To help improve students' achievement \\
Prior knowledge & To determine students' prior knowledge at start of lesson or topic \\
Teaching & To guide or modify the teaching approaches to be used \\
\hline
\end{tabular}

Though fewer themes arose from the group discussions, it is obvious that the teachers thought assessment provide information about students' learning of specific lessons, topics or concepts. For Tim, assessment goes further than determining students' understanding of concepts in that particular questions can also give an indication of how well they are able to apply these concepts to other situations. This means he knows that he can use assessment as a way of determining students' understanding and application of learnt concepts. The discussions showed no signs of the teachers' consideration of
students’ affective outcomes. In the questionnaires only a small percentage of the respondents mentioned the assessment of students’ attitudes and interests as being important. This shows that the assessment of students’ affective outcomes is not considered as being crucial.

Fiona saw assessment at the beginning of lesson or topic as being important in that it gives an idea of what prior knowledge the students have with respect to a new concept or topic as this will help guide the movement of the class through what is being taught. What could not be clear from the discussion was whether the teachers actually use the elicitation of prior knowledge to help the students make connections with the new information to be learned or just as a routine which should be done at the beginning of each lesson. Since eliciting students’ prior knowledge helps them build new knowledge by making sense of their new experiences in light of the old ones (Shepard, 2005) it would be important to find out how well the teachers make these connections during their teaching.

The teachers strongly felt that the information collected from assessments can be used by the teacher to help improve student learning especially as it involves the teacher improving on his/her teaching or having to change teaching approaches. In their opinion this could involve re-teaching sections of a lesson or whole lessons depending on the students’ responses. Paul thought it was absolutely necessary to look for a way to ameliorate the teaching situation if more than 70% of the class fails to understand the lesson. Daniel concluded that assessment results do not only serve as an indicator of students’ learning but also as an indicator of the teachers’ performance.

Daniel: I think you have to ask yourself whether the lesson was actually passed across to the students. You might be the one who has failed the test or
exam and not the students depending on the number of students that passed the exam. So if the majority fails you have to re-teach that lesson.

Discussions on how to determine the ‘success rate’ as concerns student understanding, brought up the issue of lesson objectives with Nathan saying that if the teacher states the objectives at the beginning of the lesson every student would know what is expected of them and the teacher will just be there to guide the students to attain these objectives. Tim, on his part, explains that he works closely with the national examination syllabus as this reminds the students of what they are supposed to study. He did think that if the students understand the objectives of the lesson there should be no reason for them to fail any test or exam. This shows awareness amongst the teachers of having the teacher share the learning targets with students at the beginning of the instruction process, though like in the case of Tim, his target is the exam. The following are excerpts of the some of the teachers’ responses about the importance of stating learning targets:

**Annabel:** If the goals are not clearly stated they (students) cannot know where they are driving to.

**Daniel:** I think if they (students) cannot make up, you cannot blame them. I think I cannot assess somebody on what they do not know. I have to say what I am to do. To assess is to find out what I did. If you fail to then you have done something wrong. So if the students know the objectives of the lesson and they do not meet up then they can have a small blame if the lesson was well delivered. If the objectives were not given or you have not actually prepared their minds that they are going towards this direction, then you should be aware that they will go wrong.
Teacher Feedback

The teachers’ discussion about the type of feedback they would give students, centered on the feedback they would usually give to written work. There was no mention of the feedback to other types of assessment. The general approach as elaborated by the teachers, involves teachers collecting students’ work, correcting it by placing ticks and crosses to identify right and wrong answers, and then assigning a score on the piece of work. After marking the students work, there is a ‘discussion’ of the work in class during the next class meeting. The depth of the discussion and how it fosters learning was not clear from the group discussion. For Daniel, the feedback and its promptness depend on the class size. He thought for large classes this usually takes a long time. This showed that Daniel was concerned about the time he needed to go through students’ work considering that classes are generally large. All the teachers did agree on the fact that it was important to get the corrected work back to the students and do the discussion as fast as possible as this will help students improve on their work. The manner in which the teachers deal with feedback places it at a lower level of the descriptive feedback (Tunstalls & Gipps, 1996) whereby, though they are able to specify correct and wrong answers, they do not go further to provide directions for the way forward.

Involving Students in the Assessment Process

Discussions on students’ role in the assessment process were limited to students marking the work of their peers which according to Paul and Daniel helps in that the student’s are able to get immediate feedback to their work especially as the classes are large and the teacher may not be able to go through every students work within a short
period of time. This connection between peer assessment and feedback may be an indication that Paul and Daniel value the promptness of feedback given to students and the concern they have about the effect of class size on the feedback. For Daniel, it is easy to have students on one table exchange their work with students of another table to have students mark their peers’ work as the whole class discusses the answers. Paul said he will have another class (with students of the same level and studying the same content) do the marking by taking the work of one class to the other class and the students will discuss, agree on the correct answers and then do the marking with the teacher guiding the discussion and providing the final verdict on the answer. From lesson observations it should be possible to provide the extent of the discussions that teachers have with the students about their work after the teachers do the marking. Though Paul’s approach takes more time than Daniel’s, both approaches end up substantially cutting down on the time the students will have to wait for feedback. Daniel showed he really favored the use of peer assessment strategies by noting that when students exchange, discuss and mark their work it is helpful because it could show if the students are following the lesson or not. He also thought this helps them develop the attitude of fairness in judging each other’s work. It is important to note that Daniel could see that the students gained not only cognitively but also metacognitively which is one of the strengths of involving students in the assessment process as students are provided with an increased opportunities to reflect and generalize their knowledge to new situations (Topping, 2009).

Another time saving strategy linked to group work according to Tim was to have each group submit just one copy of their work to the teacher. This meant he will spend
less time marking and can return the students' work faster even in the case of larger classes.

**Tim:** Another way as I do is, with a large class, take a hundred for example, I split it into say 10 groups. For the 10 groups I will say I have 10 scripts where one group will submit just one script. So I will now have to mark only 10 scripts. With that I now get precisely what they presume .... So in the course of marking those few scripts I am able to assess almost all of them because when they are in their groups they feel free discussing amongst themselves and not all of them can discuss freely in class.

The teachers also stated they involve the students in the assessment process through question writing. Daniel gets students to write questions which they can ask their peers. He thinks that a student can only ask a good question concerning the topic that was taught if they learnt something about the topic. Nathan agreed that from the type of questions that the students ask and the answers that their colleagues give the teachers can measure the level of understanding. For Nathan, this can be extended to getting students to ask questions not only to their peers but also to the teacher which gives an indication of the students' attainment of the lesson goals. A slightly different approach proposed by Tim, involves the teacher asking a question and picking a student to respond. If the student fails to provide a correct answer, the teacher then asks the student to direct the question to another student usually of the opposite sex to help correct the answer. According to Tim this develops some level of competition among the students and causes them to be alert and able to contribute during the lesson:

**Tim:** I think this keeps the students alert most of the times. I will ask a question, and I will point a particular student. I am pointing a particular student because I want to know the level of understanding. If the question defeats the student I will tell the student to point to any student
of the opposite sex. You see, many of them will be alert and trying to think of what will happen. If it is a female student standing up, all the males will be very alert – that the female can come to them and they need not be beaten hands-down. This brings all the students in class causing them to contribute.

This means though the teacher may be trying to find what the students know, there is also the tendency that through such competition an unsupportive classroom environment may arise which will have the effect of discouraging weaker students. This situation, according to Stiggins (2004), is generally common in high-stakes testing systems where the common belief is that raising the bar causes students to work harder, though struggling students may get intimidated and give up in hopelessness.

Summary of Teachers' Views from Questionnaires and Group Discussion

The responses from the questionnaires from the initial 28 teachers and the group discussion with the final 8 participants indicated that teachers use a variety of assessment methods which could be placed into paper and pencil (written), performance and personal communication categories. Most common was the use of oral questioning, written tests and homework. Oral questioning may appeal to most teachers as it is fast, immediate and may demand less preparation on the part of the teacher. Written tests are required by the administration and given at particular times for accountability purposes. This leaves the teachers with no choice than to administer them. It is not evident why many of the teachers indicate that they use homework as an assessment method. The teachers are aware of the importance of assessment as means of determining students understanding and achievement though their responses were limited to the assessment of achievement only in the cognitive domain with little mention of the affective and psychomotor
domains. The teachers' responses indicate that most of their feedback falls in the category of specifying attainment and does not provide students with a way of improving their work. Teachers' responses indicate a weak student involvement in the assessment process with small number of teachers responding that they involve students in some form of cooperative learning.

Lesson Observations and Interviews

General Lesson Format

Each teacher was observed twice over a period of two weeks in their usual classrooms and each of the observed lessons had a duration of 50 minutes. The lessons followed almost the same format from one teacher to the other. This format involved the teacher starting with a review session which was done through oral questioning. This review session centered on the previous lesson or on some concepts which the teacher deemed important in the students understanding of the lesson of the day. The individual interviews with the teachers provided some reasons for the review at the beginning of the lesson. The following are three of these responses:

Lucas: This (the review) is on what we did last time – trying to see if the students understand - if they understood what we did in previous lessons.

Martha: Most of them are continuations of what we did before. Therefore, I first take them back to what we did before I continue. Maybe there are some definitions that they need to know before we continue with the topic. I make them (students) recall what they did before.

Nathan: Most often when I am introducing a topic, it may have to do with what I previously taught or maybe it is just a continuation. So in order to bring the students and make them ready I need to know if they understood the past lesson. I usually start with a review because what I want to teach has some connection with what I am reviewing.
From the teachers' interview responses it can be concluded that the main purpose of this questioning at the beginning of the lesson is mainly to evaluate whether the students had learned the expected material from the previous lesson. This is more of a traditional approach as opposed to a constructivist one whereby questioning could be used at the beginning of the lesson to elicit not only students understanding of previously taught content but also to find out students' prior knowledge and misconceptions which can be used in facilitating conceptual change. These review sessions which lasted about 5 to 10 minutes were followed by a lecture from the teachers on the topic of the day. The lecture in some cases (rarely) was accompanied by demonstrations and brief whole class discussions. The lecture parts of the lessons lasted for an average of 10 minutes. During this lecture phase the teachers explained the concept or concepts the students had to learn for that day. After the lecture phase, the teacher read or wrote notes on the board for the students to copy in their notebooks. The note-taking part took most of the lesson and lasted between 15 to 20 minutes. Another five minutes at the end of the lesson went for another review and administrative procedures such as taking student attendance and filling of records. All the teachers followed this pattern in all their lessons despite having indicated during the group discussions that they could use other techniques such as students assessing each others' work. There were no hand-on activities or group activities in any of the lessons observed. At this point it was not clear if this absence of hand-on activities was due the large class size, lack of equipment, or due to the teachers not knowing what to do.
Collection of Assessment Information

From the lesson observations three main methods of assessment were evident. These included teachers observing students as they did individual work in class, assigning of homework, and oral questioning. Oral questioning stood out as the dominant assessment method which was present in all lessons with teachers asking many questions during their lesson.

Oral Questioning

The teachers asked many questions. The reviews that occurred at the beginning of lessons generally started with fast recall questions, which, as the teachers claimed, are to check for understanding or prepare students for the current lesson. In all of the lessons observed these reviews were in the form of oral questioning. No other forms of review were observed in any of the lessons. During the interviews, when asked explicitly, 6 out of the 8 teachers said it was possible to use other approaches such as fast quizzes or some group activity, though they never really gave it any serious thought.

Question Types

Ninety-seven questions from some of the lessons observed were analyzed for the types of questions that the teachers posed using Harlen’s (1996) classification into person-centered questions (questions that have no wrong or right answers because they ask students what are possible explanations of a phenomenon), subject-centered questions (questions that have only one right answer because they ask for explanations of a phenomenon) or process-centered questions (questions that ask students to do something involving the use of skills such as observing, measuring, planning and so on, but without asking for explanations of the phenomenon). Questions could only be analyzed from
lessons where the questions were asked slowly. For some of the lessons (for example, review lessons which had many questions), the questions were asked really fast making it difficult to write them as only field notes were being made. Thus, this analysis likely undercounts the amount of closed, low-level subject-centered questions. This is the classification that was to be introduced to the teachers during the workshop. Few (3%) of the teacher questions were person-centered with most of them (85%) were subject-centered questions. Of the remaining 12%, 3% were process centered while 9% could not fit into any of the three categories. Teacher questions were mostly closed (questions seeking some form of agreement) and of lower order, requiring one or just a few words as a response. Just 15% of the analyzed questions were open questions (questions that invite broad responses) with the rest being closed questions. This means questions were generally aimed at having students recalling facts without having them expressing their personal thoughts about the science phenomena they are dealing with. With the use of more subject centered and closed questions, the teachers were ‘seeking the right answer’ leaving little room for the development and sustenance of classroom dialogue.

The teachers’ questions were not often in a logical manner as they were not posed in a way which could help students make connections between concepts or science ideas and because of this it could be deduced that they do not always plan the questions they asked. When Annabel was asked if she planned the questions, she gave the following response:

Annabel: There are times I actually plan the questions. For example, when I am preparing the lesson - even though I may not write the questions down I might just try to foresee that this type of questions will be nice to ask the students before or after.
Wait Time

From studies on Wait Time, Rowe (1986) and Tobin (1987), observed changes in student discourse and higher cognitive achievement when wait time exceeded 3 seconds. Using this criterion, each of the 97 analyzed questions was checked for its Wait Time 1 (the time between when the question is asked and when a student is called). Using the stopwatch function of a mobile phone, it was discovered that only 2% of the questions had wait times of 3 or more seconds. Concerning Wait Time 2 (the time between students’ response and when teacher speaks), this was less than 3 seconds in all instances and in most cases it was difficult to observe as the teacher queued up immediately after the student or did not even allow the students to finish especially in cases where the student was giving an incorrect response. During the individual discussions all the participants admitted never having thought about wait time. For Nathan, though he never thought about it, he thought it would be important to observe good wait time. He was, however, not very certain of how much time to allow for Wait Time 1.

Nathan: I have never taken note of this. At times in class it is so spontaneous. Maybe I need to allow one or two minutes for them to reflect on the question before I assign someone to answer the question. ... because if you look at a question it is like an obstacle that you want the students to overcome. And for them to overcome the obstacle the students must be able to recall what they did in previous lessons that will link then up to be able to overcome the obstacle.

Nathan, though a trained teacher, lacked proper knowledge of the concept of wait time like the other teachers. It is likely that this could have been a contributing factor for him not practicing it. Still, upon reflecting about it, he thought wait time was necessary if
students need time to think and make connections between what they know and what they are learning.

**Student Responses**

Teacher questions were directed mostly to students who put up their hands and the number of students who usually put up their hands to answer questions ranged between 25% and 50% of the class. Student responses to questions were generally brief, often one word or a phrase of less than 5 words and involved simple recall of facts. When confronted with open and higher-order questions the students had the tendency to remain brief in their responses. They were often unable to elaborate their answers in a couple of sentences or sustain a discussion. Their body language showed signs of shyness and discomfort, such as scratching and finger biting, especially as they are required to stand before speaking in class.

Another noticeable aspect in students' responses was the use of 'chorus answers' (when many but unidentifiable numbers of students answer at once) which were often accepted by all the teachers. Though all the teachers accepted chorus answers, it was very much rampant during lessons taught by Paul, Nathan and Fiona. When asked about the prevalence of chorus answers during his lessons Nathan had the following responses:

**Nathan:** For the junior classes, when you ask a question, and it is so simple it is just a stimulus response. They just answer without you assigning a particular person to answer a particular question. But in higher classes we try to limit it in such a way that they must indicate before answering the question.

Fiona sees chorus responses as not helping in assessing students because it difficult to determine who responds.
**Fiona:** Frankly, it does not help – especially the weaker students who do not usually answer. The chorus answers will usually give the impression that everyone has gotten it but if you really lift up your head and watch, you will see that there are some people who do not answer in the chorus. They, surely, are left behind.

On what could be done to stop chorus answers, Fiona said she could not easily think of any measures while Paul and Nathan thought this could only be stopped by using disciplinary measures. The following are Nathan’s remarks:

**Nathan:** For the moment it is only through discipline. If they know that when they answer in chorus you are going to punish them, maybe they will indicate before answering a question.

These quotations show lack of the knowledge of strategies such maintaining periods of silence or ‘no hands up’ questioning which can help change the situation.

The other two methods of collecting information about students’ learning, assigning of homework and observing students as they completed individual work, were not as frequently used as was oral questioning. Of the sixteen lesson observed (two for each of the eight teachers), over a two week period, homework was assigned only in three of the lessons. This could be expected as the large classes probably discouraged the teachers from assigning homework since its correction and provision of feedback would need a lot of time as was indicated during the group discussions. Paul assigned homework at the end of both of his observed lessons while Lucas also did so in one of his lessons. In all three cases the homework was such that the students could easily copy the answers from their textbooks, needing little or no effort. For example in one of the homeworks assigned by Paul the students were asked to:

1. Define atomic number.
2. Define mass number.

Both of these questions involved direct recall of knowledge with no opportunities for application of concepts learned. Observation of students as they completed individual work was seen only in one case where the students were asked to write electronic configurations while the teacher moved round the classroom looking at the students' work.

**Use of Assessment Information**

Teachers used oral questioning to assess students' understanding. In cases where they saw the level of understanding to be satisfactory they progressed with other aspects of the lessons. In cases where they thought the understanding was not satisfactory they typically re-explained the concepts or ideas all over to the whole class with only a change in words or emphases. For example, in one of Annabel's lessons on heat transfer, she was reviewing heat transfer by conduction and convection which had been covered in the previous class. She asked the students to explain what they understood by convection. After asking the same question twice, with nobody responding, she went on to define and explain convection. It was possible to observe this with all the teachers as oral questioning was widely used in all the lessons. It was not possible to know what happened after the teachers got the homework that was assigned in the three cases mentioned as the lesson observation period was already at its end. However, when asked about what happens with the homework the teachers said they collect students work, mark them and then hold a discussion after handing the corrected work to the students.
Teacher Feedback

Teachers' feedback to students responding to oral questions was always judgmental as the teachers responded with comments such as 'yes', 'no', 'right', 'good', 'wrong', 'correct', and 'not correct' to students' answers. This was evident for all the teachers. It was extreme in Paul's lessons in that he asked students who did not give correct answers or failed to so say anything at all to stand until they could provide a correct answer to another question. This response rates low on the feedback continuum as it involves a form of punishment. On one occasion when other students laughed at a students' response Paul failed to react, a situation which would likely provide a less supportive classroom environment, as the teacher failed to show that all ideas are worthy of consideration (Harlen, 1996). When asked about judgmental feedback and its effect on students Paul said it was necessary as can be seen from the following discussion:

Now, when someone gives an answer, you say 'right', 'wrong' – do you think it has any impact on them and their learning?

Paul: Eh, when I say such things I believe that it has an impact because it is going to make the child to know that what I stood up to say was correct or was not correct. So when it is the correct thing - fine - the child will feel 'what I said was right'. This means during the test if they write it then it is fine.

What about the person who did not say it correctly and you said 'wrong'? How do you think the person will feel?

Paul: I know the person will feel bad but will want to pick up except that you are a funny person to feel bad and will not want to pick up. It is not a must that everything you say is correct. When I say 'not correct' or 'wrong' I am simply saying that what you have said is not tying with the question because they may be answering another question which is still to be asked.

There is the issue of some people who do not give the right answer and they were kept standing. Why do they have to keep on standing?

Paul: When some people do not give the right answer I tell them it is not correct but those people I keep standing are those who were unable to say a thing. When you are unable to say a thing I want you to stand and feel it as a punishment and you will know that it is always good to say a something
even if it is wrong. When you say a wrong thing and they correct you will easily assimilate it.

What if they do not know? Is it ok to punish somebody for something they do not know?

Paul: My punishment does not actually tilt in that direction because I always believe that when I talk I expect maximum understanding and that is why I always give room for any question before I finally ask my own.

No other type of feedback apart from oral feedback or comment about students’ responses or work was observed. The teachers stated that they mark students’ work such as homework which comprised placing ticks here and there and writing the total number of point or grade at the end of the piece of work. Overall feedback was judgmental with teachers failing to use students’ responses to initiate further discussion of the concepts they were studying and help students understand better. There was very little student-student dialogue during the lessons and the teachers never related the feedback to the lesson objectives.

Student Involvement in the Assessment Process

In an attempt to elicit questions from students the teachers could be heard asking, “are there any questions?”, but student questions were rare to come by. In most of the lessons there were no student questions, and in cases where there were student questions, there were usually one or two in a lesson. These questions were in most cases seeking some fast clarification from the teacher and did not lead to broad discussions. For all the 16 lessons observed there were 9 student questions which gave an average of less than one question per lesson. When asked about the absence of student questions, the common claim by the teachers was that the students were shy. This view was held by Fiona, Nathan, Paul, and Annabel.
Some form of peer assessment could be observed in Nathan’s and Lucas’ lessons. This involved the teacher assigning one student to work on the board followed by the classmates correcting the students’ work. This was observed twice, once for Nathan and once for Lucas. In one case, a student was asked to complete parts of the Periodic Table and was corrected by the rest of the class. In the other instance a student labeled a diagram on the blackboard as the other students guided and corrected him. In other instances students were asked questions by the teachers and when they couldn’t give a correct answer the teacher picked another student to correct the students’ answer. In Martha’s lessons, she asked students who gave incorrect responses to pick other students to help in giving the correct answer. By so doing the students are able to modify each others’ answers or provide their own responses.

Assessment Workshop: Teachers’ Views and Shifts in Views

All eight participants attended the assessment workshop. Data collected from the workshop included samples of participants’ work on various tasks and their individual reflections about the workshop. The first part of the workshop involved the participants studying four vignettes (Appendix E) and making decisions on some aspects of assessment (Table 17). This provided more participants views on assessment. Three other tasks on the interpretation of students’ work, questioning and giving of feedback were also done by the participants. The tasks on questioning added to the participants views on assessment while those on interpretation of students work and feedback showed some changes or shifts made by the participants. The reflections provided information on the areas where the teachers had changes in views, perceived difficulties and the help needed.
Table 17

Summary of Classroom Vignette Responses

<table>
<thead>
<tr>
<th></th>
<th>A Decomposition Vignette</th>
<th>B Fertilizer I Vignette</th>
<th>C Fertilizer II Vignette</th>
<th>D Camouflage Vignette</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Is there assessment?</td>
<td>All groups responded “Yes”</td>
<td>All groups responded “Yes”</td>
<td>Group 1, 3 &amp; 4 responded “Yes”. Group 2 “Yes/No”</td>
<td>All groups responded “Yes”</td>
</tr>
<tr>
<td>2. What information was gathered?</td>
<td>Group 1 had no response. Groups 2, 3 &amp; 4 described student investigation</td>
<td>All groups described the investigation data collected by students</td>
<td>Students could make a good report on their investigation</td>
<td>Group 1, 2 &amp; 3: no response. Group 4: students responses</td>
</tr>
<tr>
<td></td>
<td>Informed response: Students' previous knowledge of decomposition</td>
<td>Informed response: Students fairness in investigations</td>
<td>Informed response: How students assessed each other</td>
<td>Informed response: How students apply learned ideas</td>
</tr>
<tr>
<td>3. By whom?</td>
<td>Group 1 had no response. Other groups thought student collected the information</td>
<td>Group 1: Teacher Group 2, 3 &amp; 4: students</td>
<td>Group 1: Students/teacher Group 2, 3 &amp; 4: students</td>
<td>Group 1: no response; Group 2 &amp; 3: teachers; Group 4: students</td>
</tr>
<tr>
<td></td>
<td>A: Decomposition Vignette</td>
<td>B: Fertilizer I Vignette</td>
<td>C: Fertilizer II Vignette</td>
<td>D: Camouflage Vignette</td>
</tr>
<tr>
<td>---</td>
<td>--------------------------</td>
<td>--------------------------</td>
<td>--------------------------</td>
<td>--------------------------</td>
</tr>
</tbody>
</table>
*Informed response:*  
Whole class | Group 1: Students Group 2, 3 & 4: responded in terms of the task  
*Informed response:*  
Single group | Group 1 & 2: Students Group 3 & 4: responded in terms of the task  
*Informed response:*  
Individual groups | Group 1: no response; group 2 & 3: students; Group 4: the task  
*Informed response:*  
Individual students |
| 5. Who used it and how? | Group 1: no response  
Group 2: students  
Group 3 & 4: teachers  
*Informed response:*  
Teacher or student – to improve learning | Group 1, 3 & 4: Teacher  
Group 2: Students  
*Informed response:*  
Teacher or student – to improve learning | Group 1: Teacher & Students; Group 2 & 4: students; Group 3: teacher  
*Informed response:*  
Teacher or student – to improve learning | Group 1: no response; group 2, 3 & 4: teacher  
*Informed response:*  
Teacher – most likely for grades |
Classroom Vignettes Activity

Question 1: Is there assessment? While evidence is gathered in all the four cases, it is not clear how this evidence is used for the purposes of assessment in Vignette A and D. Three of the four groups thought that assessment was present in all four vignettes. The members of Group 2 were not quite sure on whether to agree on the fact that there was assessment taking place or not in Vignette C. They finally put a YES/NO response. This indicates that those who do not think assessment took place were not able to see students' collecting and using information about their report writing skills as assessment. In other words, they do not acknowledge the situation where students did self assessment at the end of their projects as valid assessment.

Questions 2: What information was gathered? The responses to Questions 2 showed that all the groups had varying degrees of understanding of the task. From their responses it could be seen that the teachers had difficulties distinguishing the collection of information about student learning and the collection of investigation data by students.

Question 3: By whom? The difficulty in identifying what information was being collected in question 2 impacted the teachers' ability to properly respond to questions 3. Despite the clarification that was given before the task, this confusion was still evident during the discussion of the results.

Question 4: About whom? For question 4, even where this confusion was not evident, and the teachers were able to respond properly as was the case with Group 2, their responses were not specific enough. They failed to mention that the assessment
involved the whole class in Vignette A, a single group in Vignette B, self and peer assessment in Vignette C, or individual students in Vignette D.

**Question 5: Who used it and how?** This question was aimed at finding out how the assessment information was used and to help lead to the distinction between formative and summative assessment. It was not evident how the information was used for Vignettes A and D. The different groups either provided a response or left the space blank for vignette A and D. For Group 2, though they mentioned that they were not told how the information was used in the case of Vignette D, they still went ahead to state that it was the teacher who used it. At this point it became obvious that the teachers did not have knowledge of the distinction between the two types of assessment: formative and summative.

**Questioning Activity**

In the second part of the workshop, the teachers used the egg and hinged mirror activities (Appendix G) to each write two questions which were discussed and grouped as person centered, subject-centered, and process centered. Table 18, 19 and 20 shows the different question categories. This showed the common types of questions that the teachers' used. Subsequent discussion of these questions and the different categories presented the teachers with a way of effectively using questioning in the classroom.

The tables show that most of the teachers' questions (62.5%) were subject-centered focusing mainly on the content and neglecting the need for questions which allowed students to express their personal ideas. Only 2 of the sixteen (12.5%) questions
Table 18
Subject-centered Questions

1. Why does the egg float in salt water?
2. Why does the egg sink in tap water?
3. What is responsible for the egg floating in salt water?
4. What causes the number of images to increase?
5. Why are there different numbers of images as you move the mirror?
6. What is the effect of the salt water on the egg?
7. What makes the number of pennies to increase as you changed the angles?
8. What is responsible for your observations in the salt water?
9. What caused the number of images to change as the angle of the mirror changed?
10. Why do you have different number of images produced in the mirrors?

Table 19
Person-centered Questions

1. How would you explain the fact the egg floated in the salt water?
2. What do you think is making the egg to float in salt water?

Table 20
Process-centered Questions

1. What do you notice as the angle between the mirrors changes?
2. What happens when you bring the mirrors closer to each other?
3. How does the angle between the two mirrors affect the number of images formed?
4. What you notice as you moved the mirror?
were person-centered and four (25.0%) were process centered. It was found that all the questions were open-ended questions. This could be attributed the type of tasks that the participants were given. It made it easy for open-ended questions to be asked.

**Interpreting Students’ Work and Giving Feedback Activity**

In the last activity, the teachers were given a fourth-graders sample work of the drawing of a crayfish and explanations of how its parts are adapted to different functions. The teachers were asked to describe what they saw in the student’s work, interpret it and determine the student’s level of performance on a scale from 1-6 using a given rubric (Appendix I). The teachers worked in four groups. Their comments are presented in Table 21.

**Table 21**

**Interpretation of Students’ Work**

<table>
<thead>
<tr>
<th>Group</th>
<th>Description of Student’s Work</th>
<th>Student’s Level</th>
</tr>
</thead>
</table>
| 1     | • Student’s work is average but more information is needed.  
     | • Student’s language is not clear. | 3               |
| 2     | • The diagram has the structure of crayfish.  
     | • The student is not clear on how to explain the adaptations. | 3               |
| 3     | • Student attempts a description of the adaptations of the crayfish.  
     | • Student is able to observe the crayfish behavior in water | 4               |
| 4     | • The student is not able to accurately describe how the crayfish escapes | Between 3 and 4 |
Group 2, 3 and 4 were able to specifically comment on what the student had done while Group 1 did not focus on the goals of the task. All the groups agreed that the student's work was at least at level 3. Group 4 thought it was somewhere in between level 3 and level 4 while group 3 thought it was at level 4. The informed assessment of the student's work was actually between levels 3 and 4 because he had relevant ideas but could apply them only in some situations. This indicates that the teachers had understood how to locate students' level by interpreting their work and this could be helpful in giving feedback.

**Teacher Feedback**

Based on the teachers' interpretation of the student's work the teachers were required to provide suitable feedback for the student. Table 22 shows the 8 teachers' feedback:

<table>
<thead>
<tr>
<th>Teacher</th>
<th>Teachers' Written Feedback</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Good diagram. Be specific and label the parts.</td>
</tr>
<tr>
<td>2</td>
<td>Your diagram has no title.</td>
</tr>
<tr>
<td>3</td>
<td>Good ideas. You need to improve on the relevant ones.</td>
</tr>
<tr>
<td>4</td>
<td>Good but you could do better in your presentation.</td>
</tr>
<tr>
<td>5</td>
<td>Carefully label and annotate your diagrams.</td>
</tr>
<tr>
<td>6</td>
<td>Your presentation is not neatly done.</td>
</tr>
<tr>
<td>7</td>
<td>Provide food and hostile situation and observe the behavior of the crayfish.</td>
</tr>
<tr>
<td>8</td>
<td>You need to observe the crayfish keenly, taking note of how it uses its parts.</td>
</tr>
</tbody>
</table>
The activity was designed to get the students to draw a crayfish, correctly label all its body parts, and explain the function of each of those parts. The specific learning goal concerned adaptation, with the students being able to understand that each part of the crayfish served a particular purpose; that each structure had a particular function. Looking at Table 22 only feedback 7 and 8 reflect the intended learning goals which means the others did not really focus on the learning goals when they gave feedback. Feedback 5, 7 and 8 are quite specific and outline how the teacher expects the students to progress in completing the work. Feedback 1, 2, 3, 4 and 6 lack the specificity needed by the students to progress. Feedbacks 1, 3 and 4 begin with judgmental words which may divert children’s attention from learning. Some of the feedback, such as 2 and 6, dealt with issues of less relevance such as neatness and presentation of work which do really help much in the student’s learning of science.

End-of-Workshop Reflections

The workshop was intended to introduce the teachers to the concept of formative assessment. It was therefore expected that they would have acquired some key ideas about some aspects of formative assessment and were expected to have some views about the use of formative assessment. At the end of the workshop the participants were given five questions to respond to:

1. What did you learn from the workshop?
2. Which particular aspects are you interested in and will attempt to use in your lessons?
3. Why do you think it is important to use these aspects in your lessons?
4. What obstacles or difficulties do you foresee in using these aspects of formative assessment?

5. What help or support will you need?

These questions presented the teachers' views after the workshop on the usefulness of formative assessment and the difficulties they anticipated in using aspects of it.

Lessons Learned from the Workshop

Table 23-27 summarizes the comments from the teachers' reflections with respect to the five questions above. Tables 23 and 24 show the aspects which the teachers said they learned and which they think will be useful. It is interesting to find that the first three items in Table 23 can also be found at the top of Table 24.

Table 23

Lessons Learned from Assessment Workshop

<table>
<thead>
<tr>
<th>Lessons Learned</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Formative assessment cycle/differences with summative assessment</td>
<td>6</td>
</tr>
<tr>
<td>2 Use of non-judgmental comments/feedback</td>
<td>6</td>
</tr>
<tr>
<td>3 Using open, person-centered questions</td>
<td>3</td>
</tr>
<tr>
<td>4 Explicitly stating the goals of the lesson</td>
<td>1</td>
</tr>
<tr>
<td>5 Assessments involves more than just exams and questioning</td>
<td>1</td>
</tr>
<tr>
<td>6 Use of self and peer assessment</td>
<td>1</td>
</tr>
<tr>
<td>7 Use of comments only</td>
<td>1</td>
</tr>
</tbody>
</table>
Table 24

Specific Assessment Aspects to Use

<table>
<thead>
<tr>
<th>Aspects of Formative Assessment to Use</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Open, person centered questioning</td>
<td>5</td>
</tr>
<tr>
<td>2 Use of formative assessment cycle</td>
<td>4</td>
</tr>
<tr>
<td>3 Non-judgmental comments</td>
<td>3</td>
</tr>
<tr>
<td>4 Self/peer assessment</td>
<td>1</td>
</tr>
<tr>
<td>5 Wait time</td>
<td>1</td>
</tr>
</tbody>
</table>

These are the aspects the teachers consider as important and will strive to use in their lessons. An important finding was that, although they had been using aspects of formative assessment, the whole concept of formative assessment was new to them. Some of the teachers' reflections show this:

**Annabel:** I have learned the differences between formative and summative assessment. In addition to this I have understood that if formative assessment is properly done, summative assessment becomes much easier, with impressive results. I have also learned that there are different types of questions such as person-centered, subject-centered, and process-centered and these can be open or closed. Open, person-centered questions are best because they show the diversity in student thinking and can be most useful in the classroom. I have also learned that the feedback I give students should be non-judgmental as this [judgmental feedback] can discourage some students and make them feel they know nothing or feedback like 'very good' can make some students not to listen to further explanations.

**Martha:** The way I will be questioning students now will have to take into consideration whether the questions elicit students' understanding and lead to action or use of process skills. The questions should be able to invite students to express their own ideas. When asking questions I should be aware that thoughtful answers from the students require time and I should see all ideas as being worthy, whether scientifically correct or not.
Fiona: ... as a teacher most of the time I should ask open, person-centered questions which will enable me penetrate students' minds and redirect my task.

Having six out of the eight teachers express being aware of the two types of assessment is an indication that were not aware of this before the workshop. Table 25 presents the reasons the teachers gave for deciding to embrace formative assessment. All of the teachers said they were going to use various aspects of formative because it either aids students' in their learning or understanding. For example:

Annabel: These ideas make the students to really understand what I am teaching, and at the end produce good results. I am really going to use these ideas during my lessons because from what I have understood about formative assessment (from research), if properly used it will be easier for students to understand.

Fiona: I will use these ideas because when I reflect on some of my lessons, I notice that sometimes when I employed some of these ideas without really knowing, the impact was really different and positive.

Table 25

Reasons for Using Aspects of Formative Assessment

<table>
<thead>
<tr>
<th>Reasons</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Improves student learning</td>
<td>7</td>
</tr>
<tr>
<td>2 Helps teachers improve teaching</td>
<td>3</td>
</tr>
<tr>
<td>3 Helps students understand</td>
<td>2</td>
</tr>
<tr>
<td>4 Students assess themselves and fast</td>
<td>1</td>
</tr>
<tr>
<td>5 Guides attainment of objectives</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 26 shows the teachers anticipated difficulties while Table 27 presents the type of support the teachers indicated that they will need.
### Table 26

Possible Obstacles/Difficulties in Using Formative Assessment

<table>
<thead>
<tr>
<th>Obstacles/Difficulties</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Large class size</td>
<td>6</td>
</tr>
<tr>
<td>2 Lack of laboratory equipment</td>
<td>4</td>
</tr>
<tr>
<td>3 Lack of teaching resources</td>
<td>4</td>
</tr>
<tr>
<td>4 Lack of student textbooks</td>
<td>3</td>
</tr>
<tr>
<td>5 It is difficult to avoid reinforcing students</td>
<td>1</td>
</tr>
<tr>
<td>6 Inadequate time on timetable for science subjects</td>
<td>1</td>
</tr>
<tr>
<td>7 Much material to cover (affects aspects such as wait time)</td>
<td>1</td>
</tr>
<tr>
<td>8 Lack of teacher skills</td>
<td>1</td>
</tr>
<tr>
<td>9 Students not prepared to change (lack of skills)</td>
<td>1</td>
</tr>
<tr>
<td>10 Lack co-operation from other teachers and hierarchy</td>
<td>1</td>
</tr>
</tbody>
</table>

### Table 27

Teachers’ Needs and Support

<table>
<thead>
<tr>
<th>Needs/Support</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Teaching materials</td>
<td>3</td>
</tr>
<tr>
<td>2 Improved infrastructure</td>
<td>1</td>
</tr>
<tr>
<td>3 Co-operation with other schools, institute, etc</td>
<td>1</td>
</tr>
<tr>
<td>4 Parents buy students’ textbooks</td>
<td>1</td>
</tr>
<tr>
<td>5 Equipped labs</td>
<td>1</td>
</tr>
<tr>
<td>6 Support from administration</td>
<td>1</td>
</tr>
<tr>
<td>7 Support from colleagues</td>
<td>1</td>
</tr>
<tr>
<td>8 Regular source of pedagogic expertise</td>
<td>1</td>
</tr>
</tbody>
</table>
The main difficulty expressed by the teachers was the problem with large class size. The next major class of the difficulties had to do with materials such as teaching aids, laboratory equipment and the availability of textbooks. In terms of the support needed to implement formative assessment, the need for teaching materials was at the top of the list. How the teachers go about looking for the equipment or use whatever equipment is available is left to be seen during the lesson implementation phase when they will be given the opportunity to look for the equipment they need. It was interesting that, when asked about the support they need, the teachers did not mention the need for small class size. This may be because they see it as being difficult or impossible to achieve. There were also some issues raised, though not by many, which showed some real concerns about the use of various formative assessment strategies. The following two quotes show two of the teachers' concerns about the use of aspects of formative assessment:

**Fiona:** Some students are highly complex and do not want to share their ideas with others in class. Sometimes also the time allocated for a lesson may be too small. Sometimes as a teacher you either get too excited or too hurt about a student's performance in a task and this makes you to give judgmental feedback like excellent, wrong, and so on.

**Martha:** The idea of giving 'wait time' may not be possible when there is a lot of work to cover. Some students may be naughty and when you give them time to reflect and answer a question they may not make any effort to answer. Also, if you do not challenge students at times, by making negative and positive comments, they will not sit up.

The two quotes show some areas where change could be difficult which could be as a result of the beliefs the teachers hold about some aspects of formative assessment.
Summary of Views and Practice from Observed Lessons and Workshop

Observation of teachers’ lesson showed little or no evidence of knowledge of the concept of formative assessment or formative assessment cycle. Lessons typically followed the pattern of “review–lecture–note-taking”. In some cases the review of previous knowledge had no connection to the rest of the lesson. Workshop activities also showed that half of the teachers were not able to determine exactly the type of assessment information to collect in order to improve student learning or explain how to use it. There was little diversity in terms of the use of assessment methods with oral questioning being the dominant method and little use of student observation and homework. Other assessment methods, especially those involve hands-on or group activities, were not observed in the lessons, resulting in little or no role for students in the assessment process. In the use of oral questioning, more than three-quarters of the questions were subject-centered and closed with inadequate wait time. Overall, the teachers do not systematically collect, analyze or use formative information about student learning. Teachers’ feedback was largely judgmental with students being punished in some instances for failing to provide the correct responses to questions. Teachers could interpret students’ work but their feedback was lacking in specificity and directions on how students could improve their answers.

The teachers’ end of workshop reflections showed appreciation for the knowledge they gained about formative assessment notably concerning the use of the formative assessment cycle, feedback types and use, and the importance of using person-centered, closed questions. The teachers, however, saw large classes and lack of resources such as laboratory equipment and textbooks as the main obstacles to their use formative
assessment. They did not, however, see lack of assessment skills as a big obstacle at this point.

**Lesson Planning and Implementation**

**Lesson Observation: Group 1 - Lesson 1**

Group 1 comprised Paul, Annabel, Tim and Fiona. Their lesson was on the separation of solid-solid mixtures. The lessons for Group 1 were taught by Paul. The class had 140 students with an average age of 11 in a 7m x 6m room. All the students sat on benches and faced the teacher.

**Use of Formative Assessment Cycle**

The lesson plan showed written objectives related to the science content with no reference to process skills or student attitudes. These objectives were, however, not explicitly stated to the students during the lesson. The lesson plan showed the different teacher and student activities that were to be done during the lesson alongside planned teacher questions. The lesson format had some differences from what was observed during the initial (pre-workshop) lessons, whereby, there was a brief review at the beginning, followed by a lecture and then note-taking. In this lesson, there was a review of prior knowledge on the states of matter which was needed in the development of the lesson on mixtures and their separation. The teacher asked some open questions and involved the students in a whole class discussion. This was followed by student activities (students working in groups to separate substances), making of a summary of the students ideas by the teacher and then a final section to check for student understanding, through
oral questioning, of the different concepts encountered in the lesson. This lesson format showed a change from the usual format of questioning-lecturing-note taking to one where the teacher guided students in activities, assessing their ideas and summarizing student’s ideas at the end.

**Collection of Assessment Information**

Oral questioning was the dominant assessment method during the lesson. The lesson plan showed planned questions which were to be used during all the phases of the lesson indicating that assessment occurred throughout the lesson and not just at the end. Table 28 shows the different aspects of teacher questioning and their occurrences during the lesson.

**Table 28**

**Aspects of Oral Questioning Group 1: Lesson 1**

<table>
<thead>
<tr>
<th>Assessment Aspect</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subject-centered questions</td>
<td>61.1</td>
</tr>
<tr>
<td>Person-centered questions</td>
<td>19.4</td>
</tr>
<tr>
<td>Process-centered questions</td>
<td>19.4</td>
</tr>
<tr>
<td>Other types of questions</td>
<td>0</td>
</tr>
<tr>
<td>Open questions</td>
<td>38.9</td>
</tr>
<tr>
<td>Closed (skinny) questions</td>
<td>61.1</td>
</tr>
<tr>
<td>Feedback</td>
<td></td>
</tr>
<tr>
<td>Non-judgmental</td>
<td>83.3</td>
</tr>
<tr>
<td>Judgmental</td>
<td>16.7</td>
</tr>
<tr>
<td>Wait time</td>
<td></td>
</tr>
<tr>
<td>More than 3 s</td>
<td>52.8</td>
</tr>
<tr>
<td>Less than 3 s</td>
<td>47.2</td>
</tr>
</tbody>
</table>
The teachers’ questions were dominated by subject-centered questions (61.1%) with
few person-centered (19.4%) and process-centered (19.4%) questions. A greater number
of the questions, (61.1%), were closed questions which often required students to respond
using just one word or a few words. For 52.8% of all the questions, the teacher observed
wait time of 3 or more seconds. Oral questioning sessions did not lead to open or
extended discussions which could have been helpful in the learning process.

**Teacher Feedback**

The teacher’s response to students’ answers was mostly non-judgmental. After
83.3% of the questions the teacher stayed quiet, gave a hint or asked another question.
The use of judgmental responses such as ‘no’ or ‘wrong’ was not observed. This was
replaced by ‘not quite’ in some cases. The teacher, however, still had problems dealing
with negative reactions such as students laughing or ridiculing others students for their
responses. In one instance, when the students’ laughed at one of the student’s response,
the teacher joined in the laughter. The teacher also struggled when confronted with
multiple and contrasting viewpoints by different students. For example, at one point the
teacher compared two students’ approaches to solving a problem and ended up picking
one as the better one without letting the students adequately discuss the two approaches
despite the fact the students were actually asking more questions and wanting more
discussion about the different approaches. The following is part of the classroom
discussion:

**Teacher:** Now, what do you notice from Cecilia? What do you notice?
**Student 1:** She has blown the particles.
**Teacher:** What did you see Tatiana doing? Repeat what she did and let us see.
One student performs the task while the other students watch.

Teacher: If you look at the two methods, which is the best and why?
Student 2: Tatiana's.
Teacher: That is her idea.
Student 3: Cecilia's.
Teacher: Listen to the ideas.
Student 4: Tatiana's.
Teacher: Not quite. One last try.
Student 5: Tatiana's method is correct.
Teacher: So you think Tatiana's own is correct. OK, look at something here. We have "egusi" (melon seeds) and groundnut peelings here and I have asked which method is the better method. Some of you are saying Cecilia's is the better one.

Students (in chorus): No, sir.
Teacher: And some say that Tatiana's is the best. Give a reason for your idea. Now - OK. Look. (Teacher performs the activity himself). Have you seen? So if you notice, this method will even remove some of the solid particles and you will not have anything left. So what Tatiana did was better.

Though the teacher provided an opportunity for the students to give their own ideas he exhibited some judgmental tendencies by responding in a norm-referenced manner that compared individual student's responses (Shute, 2008). He pushed a particular viewpoint through without adequate discussion.

Student Involvement in the Assessment Process

There was an attempt to use group work and the subsequent whole-class discussions for assessment of students' ideas. The groups were, however, not clearly defined, and the whole-class discussion was limited. The teacher did not take time to form the groups and groups were very large with about 10-15 students per group. Considering that peer assessment and group work can complement each other (Topping,
2009) this lack of well-formed groups could have hindered extensive discussion and therefore peer assessment among the students.

Post-Lesson Discussion

The post-lesson discussion of Group 1’s first lesson focused on the same four aspects stated earlier: evidence of formative assessment cycle, information gathering methods, feedback use, and students’ role in the assessment process.

Use of Formative Assessment Cycle

The teachers saw formative assessment in play especially with the inclusion of student activities which provided an opportunity for the teacher to observe the students as they carried out these activities. Tim, however, thought the teacher’s failure to state the objectives of the lesson undermined the students’ ability to know exactly what was expected of them. The instructor (Paul) argued that it was not necessary to state the objectives in every lesson.

Information Collection Methods

Not much was brought up on the information collection methods. There was no mention of questioning, the types of questions used, and the use of wait time. Lucas mentioned that Paul was doing a good job of discouraging chorus answers by simply pointing it out instead of punishing those who gave chorus responses.
Teacher Feedback

Most of the discussion focused on the teacher's feedback to students' oral answers. Apart from Tim, all the other teachers appreciated the shift from the use of 'wrong,' 'no' or 'correct' or 'good' to 'not quite' or staying silence after students' answers. Tim thought it would be better to let the students' know if an answer is correct or wrong by out-rightly saying so. The rest of the teachers thought that, though, 'not quite' was still judgmental, it was however, not as hard as the use of 'wrong,' 'not correct' or 'no' in the case of incorrect answers. Below is part of the discussion the ensued:

**Tim:** OK, now, if I say '3 multiplied by -2' and the student says 1, reasoning as '3 plus -2' I will say the answer is not correct - we are multiplying - what do we do?

**Paul:** If I say 'not quite' the reason is because I want to create a forum for brainstorming. If you finally gather the ideas, you will get one from here, one from there, and use that to form the correct answer. I will say that 'what you have said is not totally wrong' because instead of using multiplication as the question recommended you used addition and this person will easily correct that.

**Annabel:** I see formative assessment in what he (Tim) is saying because when the student gives an answer, the response is showing what the child is doing addition. You clearly identified that and reminded the child that the operation is multiplication and not addition and ask them to try again instead of saying wrong.

Paul and Annabel's comments indicated they understood the importance of elaborated feedback (going as far as describing why the student's answer is wrong) rather than just saying the student was wrong as was the case in the pre-workshop lessons.

Lucas brought up the issue of students laughing at other students' responses and the teacher taking no action. He thought Paul should have discouraged those who laughed as well as say something to encourage the student who asked or answered the question. Daniel thought laughing is only acceptable when the topic of discussion is interesting or
funny and not when students laugh because a student’s response is awkward. Annabel labeled the laughing as negative feedback while Tim thought there should a class rule to discourage laughing at student responses.

**Tim:** Maybe there should be a class rule at the beginning that people should not laugh at responses and should be asked to put up their hands if think differently and say, ‘I differ from this because …’

Tim said that the teacher’s comparison of two student’s answers (Cecilia’s and Tatiana’s) without allowing for adequate discussion amounted to forcing them to accept one view as being the correct one. Lucas thought that directly saying one student’s approach is not good kills the spirit of discussion and discourages students from participating. These ideas from Tim and Lucas compares to Kluger and DeNisi’s (1996) research in Shute (2008) which indicates that when feedback is provided to students in a manner that compares an individual’s performance with that of another, the student who performs poorly tend to attribute his or her failure to lack of ability, expects to perform poorly in the future exercises, and may result in decreased motivation on subsequent tasks.

**Student Involvement in the Assessment Process**

Annabel thought that allowing the students to discuss their ideas provided an opportunity for peer assessment. Annabel, Lucas and Paul thought that student responses should be followed by an opportunity for them to discuss the different answers leading to the point where the students will be able to understand why an answer is acceptable or not acceptable. According to them, this provides an opportunity for peer assessment which is helpful in conceptual change. Tim said it was evident the student were assessing
each other as they were able to comment on each other's answers though they were not adequately provided the opportunity to do so by the teacher.

**Lesson Observation: Group 1 - Lesson 2**

**Use of Formative Assessment Cycle**

The second lesson was taught five days after the first one. The lesson plan showed few differences from that of Group 1's first lesson. The teacher, however, indicated the inclusion of student activities and group work in the lesson plan. In this lesson the objectives were stated though they were not emphasized, which, shows a small difference from the first lesson in which the objectives were not stated at all. Like in the previous lesson, the teacher did a review to check on students' prior knowledge about matter. This knowledge about the 'states of matter' was then linked to the identification of the states of the substances in the mixtures to be separated and how they could be separated. The teacher engaged the students in more activities than in previous lessons giving them the opportunity to be active partners in their own learning by collecting different student ideas and making a summary of these ideas. The lesson had a review period at the end during which there was checking of the students' understanding of the separation methods they had encountered.

**Collection of Assessment Information**

Oral questioning remained the most used method of collecting information about student learning during this lesson. However, there was more student involvement in this lesson than in the first lesson. For example, after the students named various states and
types of matter during the review session, the teacher asked the students to work in
groups to discuss and classify the different types of matter into the three states of matter.
The teacher had the opportunity to observe the students during the group activities and
discussions.

Table 29

<table>
<thead>
<tr>
<th>Assessment Aspect</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subject-centered questions</td>
<td>63.9</td>
</tr>
<tr>
<td>Person-centered questions</td>
<td>30.5</td>
</tr>
<tr>
<td>Process-centered questions</td>
<td>2.8</td>
</tr>
<tr>
<td>Other types of questions</td>
<td>2.8</td>
</tr>
<tr>
<td>Open questions</td>
<td>41.7</td>
</tr>
<tr>
<td>Closed (skinny) questions</td>
<td>58.3</td>
</tr>
<tr>
<td>Judgmental feedback</td>
<td>0</td>
</tr>
<tr>
<td>Wait time</td>
<td></td>
</tr>
<tr>
<td>More than 3 s</td>
<td>22.2</td>
</tr>
<tr>
<td>Less than 3 s</td>
<td>77.8</td>
</tr>
</tbody>
</table>

Table 29 shows that the teacher still used many subject-centered questions. There was no
improvement from the previous lesson but when compared to pre-workshop lessons
which showed that 85% of the questions were subject-centered questions, there appears
to be much improvement. The use of person-centered questions increased by 11.1% from
the first lesson though the number of process-centered questions was fewer than in the
first lesson. Open questions also showed a small improvement.

The teacher's use of wait time of 3 or more seconds showed a considerable
reduction from the 52.8% in the first lesson to the 22.2% in the second lesson which may
be an indication that the teacher does not yet consider the use of adequate wait time as being important in the assessment and learning process especially as this was not mentioned in the first post-lesson discussion. The total number of questions in each of the two lessons remained the same (36 in each lesson) despite the considerable reduction in questions with wait times of more than 3 seconds.

**Teacher Feedback**

There was an absence of judgmental feedback. The teacher did not use judgmental responses which were common prior to the workshop.

**Student Involvement in the Assessment Process**

As the students assumed a more active role in this second lesson and were engaged in many more hands-on activities it was possible for them to have more discussions and assessment of each other's ideas. The groups were smaller and clearly indicated ensuring proper coordination by the teacher. There were also demonstrations and presentations by individual students based on the results of the activities in their groups. The teacher made the students reflect and comment on the answers of their peers.

**Lesson Observation: Group 2 - Lesson 1**

Group 2 was made up of Nathan, Lucas, Martha, and Daniel. Both lessons for the group were taught by Nathan. The class had 156 students in a 7m x 6m room. The class
was a mixture of twelve and thirteen year old boys and girls. This group also chose a lesson on mixtures and their separation.

**Use of Formative Assessment Cycle**

The lesson had a review of previous knowledge at the beginning about the states of matter which was required for the students' understanding of the lesson on types of mixtures and how to separate them. This was done through oral questioning with the teacher picking students who put up their hands. The review of prior knowledge was followed by a series of tasks where the students formed different mixtures and separated them with the teacher observing the students as they worked. These tasks were interspersed with discussions on the choice of the methods used by the students. The lesson ended with an assessment by the teacher and students assessing each other's work. The use of assessment at different places in the lesson, and not just at the end of the lesson shows teachers are using assessment to build on student learning indicating more awareness of the use of the concept of the formative assessment. The objectives of this lesson were not clearly stated.

**Collection of Assessment Information**

Oral questioning was the main method of collecting assessment information. Table 30 shows that most of the questions were subject-centered (63.6%) - with a small percentage of person- (15.1%) and process-centered (15.1%) questions. Also a smaller percentage of the questions were open-ended questions (21.2%) with the rest being closed questions. Wait time of 3 or more seconds was observed for 12.1% of the
questions asked. The teacher was also able to observe students as they carried out the
tasks he assigned. He asked scaffolding questions as he observed the students working.

Table 30
Aspects of Oral Questioning Group 2: Lesson 1

<table>
<thead>
<tr>
<th>Assessment Aspect</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subject-centered questions</td>
<td>63.6</td>
</tr>
<tr>
<td>Person-centered questions</td>
<td>15.1</td>
</tr>
<tr>
<td>Process-centered questions</td>
<td>15.1</td>
</tr>
<tr>
<td>Other types of questions</td>
<td>6.1</td>
</tr>
<tr>
<td>Open ended questions</td>
<td>21.2</td>
</tr>
<tr>
<td>Closed questions</td>
<td>78.8</td>
</tr>
<tr>
<td>Feedback</td>
<td></td>
</tr>
<tr>
<td>Judgemental</td>
<td>18.2</td>
</tr>
<tr>
<td>Non-judgemental</td>
<td>81.8</td>
</tr>
<tr>
<td>Wait time</td>
<td></td>
</tr>
<tr>
<td>More than 3 s</td>
<td>12.1</td>
</tr>
<tr>
<td>Less than 3 s</td>
<td>87.9</td>
</tr>
</tbody>
</table>

Teacher Feedback

Concerning feedback the teacher avoided the use of the use of 'no', 'yes',
'correct' or 'wrong' when responding to students' answers. He used 'not really' or 'not
quite' for 18.2% of the student responses. For other 81.8% of the responses the teacher
stayed quiet or asked a leading question. At the end of the lesson the teacher marked the
books of the first ten students who finished the review questions he assigned. During the
group discussion he said he had no reason why he marked the first ten books. He used
ticks and crosses and assigned a final score with no further comments on how to improve
the work.
**Student Involvement in the Assessment Process**

The students worked in large groups which overlapped into each other with some students not knowing the groups to which they belonged. One student from each group demonstrated what they did in their groups while the rest of the class observed and made comments. This provided an opportunity for teacher assessment as well as peer assessment. The teacher made efforts to initiate whole class discussions as the students explained what they did in the tasks. The rest of the students whose work was not checked by the teacher exchanged their books and after provision of the acceptable answers by the teacher they were able to mark each other's work, placing ticks and a final score at the end. There was no direct discussion between the students as they corrected each other's work.

**Post-Lesson Discussion**

**Use of Formative Assessment Cycle**

The teachers acknowledged evidence of the use of formative assessment and the formative assessment cycle. Nathan on behalf of Group 2 said they saw formative assessment in the lesson in that they started the lesson by assessing students' prior knowledge as concerns matter and its states which they used in building the lesson on mixtures. In addition to that they thought that by making the activities student-centered formative assessment was actually in play. The following are Nathan's comments:

**Nathan:** Concerning formative assessment, I can say there was quite a bit because, first of all, the lesson started by assessing the previous knowledge from the students and then from that I used that knowledge to link up with the task of the day. Then all of our activities were centered towards students because in most of the activities the teacher
was there just to guide the students. They were the ones performing the activities. So actually there was formative assessment using questioning and also carrying out tasks. So there the teacher was there just to observe what the students were doing. After they performed the activities the teacher gathered some information, interpreted or transformed it into scientific knowledge.

Nathan's comments showed an understanding of the basic of concept of formative assessment by understanding that he had to engage students in various activities, collect information about their learning, and then providing guidance and feedback in order to achieve the objectives of the lesson. Nathan, however, said he only stated the objectives of the lesson implicitly because the lesson was being re-taught and he did not want the children to immediately know where he was heading to.

Collection of Assessment Information

From the discussion the teachers mentioned the two main methods by which the teacher gathered information about students learning: oral questioning and observation as the students performed various tasks. Most of the discussion centered on the use of oral questioning. All the teachers thought that subject-centered question made up the bulk of the questions, with just a few person-centered and process-centered ones. This showed some agreement as can be seen in Table 30. Paul had the following comments about oral questioning:

Paul: Many of the questions were subject-centered. I did not find many situations where he (Nathan) asked questions that required the students to actually think and say 'I am using my answer because of this' and then another student will challenge it and say it is because of this that I am using handpicking. I think the questions were mainly subject-centered.
Teacher Feedback

There wasn’t much discussion about feedback. It was barely mentioned that the teacher avoided giving judgmental responses to students’ answers and that he chose not to say anything in most of the cases. The participants did mention that he gave points instead of making comments about students work.

Student Involvement in the Assessment Process

The teachers saw the assessment activity at the end of the lesson as being important because the teacher could actually see if learning had taken place. Paul suggested that by the students discussing their ideas during the group activities they were able to assess each other. According to Paul, when students do activities, especially in groups, they are provided with an opportunity for discussion and critiquing of their different ideas.

Lesson Observation: Group 2 - Lesson 2

Use of Formative Assessment Cycle

A number of aspects showed some improvements as far as formative assessment was concerned when the second lesson was compared with the first. There was more evidence of the use of the formative assessment cycle. The teacher collected students’ prior knowledge in a much more participatory approach with the students naming different types of matter and other students helping one student on the blackboard. This did not just involve naming items but classifying them and giving reasons for their classifications. This information was then used in building the rest of the lesson with the
teacher coming back at the end of the lesson to find out if the students had understood. This showed that the teacher was able to collect information which he used in guiding student learning.

**Collection of Assessment Information**

In addition to oral questioning, there were many attempts by the teacher to use a variety of assessment methods. The use of other assessment methods such as observation of students as they completed various tasks, and construction of concept maps with students, provided many multiple opportunities to check and guide student learning unlike before when the teachers used only oral questioning. There were definite and well-structured groups with fewer students in each group than in the previous lesson. The teacher observed and directed the students in various tasks through oral questioning. Students were involved in classifications, construction of concept maps, presentation of their work and whole class discussions. This indicated quite a shift from the usual method of oral questioning, where just a handful of students or the same students participated, to one where many more students were participating making it possible for the teacher to assess many more students.

Table 31 provides an overview of the different aspects of oral questioning from the lesson. The teacher asked less subject-centered questions and more of person-centered and process-centered questions with a doubling of open questions as compared to the previous lesson. Also there was a five-fold increase in the teacher's use of a wait time of 3 or more seconds from the first to the second lesson. The teacher was also able to use the "no hands up" rule giving each student the opportunity to think and respond to the
questions. This was quite noticeable because all through the lesson planning and implementation process it had not been addressed by the teachers.

Table 31
Aspects of Oral Questioning Group 2: Lesson 2

<table>
<thead>
<tr>
<th>Assessment Aspect</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subject-centered questions</td>
<td>47.1</td>
</tr>
<tr>
<td>Person-centered questions</td>
<td>26.5</td>
</tr>
<tr>
<td>Process-centered questions</td>
<td>23.5</td>
</tr>
<tr>
<td>Other types of questions</td>
<td>2.9</td>
</tr>
<tr>
<td>Open questions</td>
<td>44.1</td>
</tr>
<tr>
<td>Closed questions</td>
<td>55.9</td>
</tr>
<tr>
<td>Teacher Feedback</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Non-judgmental</td>
</tr>
<tr>
<td></td>
<td>Judgmental</td>
</tr>
<tr>
<td>Wait time</td>
<td>More than 3 s</td>
</tr>
<tr>
<td></td>
<td>Less than 3 s</td>
</tr>
</tbody>
</table>

Teacher Feedback

Unlike in the previous lesson where the teacher checked students' work and awarded points, there was discussion of students' work and provision of immediate and lots of feedback as the students' were able to have multiple perspectives and not just that of the teacher. As can be seen from Table 31, the teacher's responses to students' answers were non-judgmental. A consequence of this is that the teacher was able to reflect and ask more thoughtful follow-up questions rather than just responding with as 'yes' or 'no' as he did before. This means the teacher had moved away from the point of just approving
or disapproving students' work to one where he was involving the students in diagnosing and articulating the way forward (Tunstall & Gipps, 1996). He asked students more "what do you think?" questions. By having whole class discussions, prompting and scaffolding of the students there was the creation of possibilities for learning and checking of student knowledge.

Student Involvement in the Assessment Process

The effective use of student groups and the subsequent whole class discussions that followed provided more room for student interaction which enhanced students' assessment of each other. This was evident in the case where one student worked on the blackboard and the other students guided in classifying various substances under the different states of matter. In this case the students were able to judge and agree or disagree with each other's answer. This provided a forum for peer assessment with the teacher moderating the discussions. The teacher provided the students with more opportunities to comment on other students' responses or provide their own opinions. Though the teacher collected more student ideas than in the previous lesson he was not able to hold long class discussions as there were few open, person centered follow-up questions.

End of Cycle Discussion

Use of Formative Assessment Cycle

The teachers' discussions showed they had a better understanding of formative assessment and the formative assessment cycle than before. There was the general
conception that it is important to state the lesson goals or teacher expectations at the beginning of the lesson. The teachers felt that stating the objectives (though only implicitly in some cases) followed by the use of oral questioning and other strategies to elicit students prior knowledge and the subsequent integration of the ensuing ideas in the lesson activities, meant there was formative assessment and use of the formative assessment cycle. The following are Paul’s statements about the use of formative assessment in Nathan’s second lesson:

Paul: There was formative assessment because he (Nathan) started the lesson with questioning to activate the students’ mind and those questions formed the teaching questions within the lesson. With the introductory questions, and as he was teaching, he was now thinking about the activities. This means he was now linking the introduction to what was happening in the lesson.

Paul’s statements showed that he appreciated the importance of assessing students’ prior knowledge and how it can be used to make sense of the new experiences the students are going to have in the lesson. This is different from the initial pre-workshop lessons when oral questioning at the beginning of the lesson was seen as part of a routine and had little or no connection with the rest of the lesson.

Collection of Assessment Information

During the discussion, the teachers explained that observing students as they engaged in different classroom activities was just as important as oral questioning, which was previously dominant. For Lucas and Paul, having the teacher moving around the classroom and observing the students as they performed various tasks or engaged in discussions, and asking leading and prompting questions provided an opportunity to
determine the point the students were in the course of attaining the goals and help direct
the students' in attaining the learning goals. Concerning questioning, they identified the
increase in the number of person-centered questions in both of the second lessons by each
of the groups. Lucas thought the use of student-centered questions allowed each student
to answer a question or explain something in his or her own way. Missing from the
whole discussion was the aspect of wait time. This again showed that the teacher still had
not placed much importance on it as far questioning was concerned.

**Teacher Feedback**

The teachers were quick to mention that the feedback in both of the lessons was
non-judgmental. They mentioned that the there were no comments that showed disproval
or approval of students' answers. This was an important point as the teachers had
previously been used to negative feedback which could have resulted to self-image issues
for the students and subsequent poor performance or unwillingness to participate in class
discussions. Lucas mentioned the absence of punishments, which in the past was seen by
most of the teachers as being normal.

**Lucas:** There was time when a student stood up and said something and
Nathan's face went bad. If it were in the past he would have given the
child a knock but ...

Tim also mentioned the case of students laughing at another student's answer and the
teacher's failure to react. He thought this would have an effect on the classroom
environment in that it would discourage some shy students from speaking in class. Paul
mentioned that using students' answers and questioning them further provided immediate
feedback as well as 'links' throughout the lesson. This indicates that feedback was in the form of constructing a way forward towards the attainment of the lesson objectives.

Student Involvement in the Assessment Process

The discussion on how the students interacted with each other during the lesson provided signs of the teachers’ awareness of how students could be instrumental as instructional resources for one another (Wiliam & Thompson, 2007). The teachers placed a lot value on student discussions in their groups and as a whole class with Lucas viewing the dialogue among students as important for gathering information about student learning by the teacher though it may actually need more time. Tim thought in such situations, in order to allow for peer and self assessment and also collect more information about student learning, it is important to give the students more time. Tim had the following ideas about peer assessment in the lesson:

Tim: The students were assessing themselves and not leaving out their mates because we heard other students being asked 'what do you think about this?' When one gave an answer, another one will give a comment. ... there are situations that we need to give the students some time. Like the case of rice and 'garri' (cassava flour). When one student says we use a sieve, another one stands up and says 'no, you use this'. That will bring up another slot for them to think and start an argument. It is like they are starting another lesson.

Lucas agreed with Tim concerning providing more discussion time. He said through proper discussions it is possible to clearly understand students’ thinking which is important in helping teachers determine the type of feedback to give students and move learners forward in the learning process. Tim specifically thought at this point the teacher
could easily make decisions on what new directions or tasks to provide which will help the student in their learning.

Tim: For example, in this case, it makes you realize that the students have embarked on a single method of separation (of the mixture). You can then give another example of the task that you are facing ... That will now widen the scope and they (students) will know that they should not only use one method to separate mixtures.

Lucas has this to add:

Lucas: From the students’ arguments, you could notice that the students came to know that you can use not just one method to separate a mixture.

The teachers also mentioned that if at the end of the lesson there still much argument among the students and the task is not completed, it was necessary to show some flexibility by giving the uncompleted work as homework and returning to it in the next lesson, rather trying to discarding the students’ ideas.

End of Cycle Reflections

Use of Formative Assessment Cycle

Table 32 shows the themes extracted from the teachers’ end of cycle written reflections showing the important aspects they learned from the whole process. Though these aspects show a good deal of similarity to the post-workshop ideas, the reflections in this case showed more thoughtfulness as they were able to link these aspects to the lesson planning process and some of their initial practices.
Table 32

Formative Assessment Aspects Learned

<table>
<thead>
<tr>
<th>Formative Assessment Aspects</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Formative assessment model versus summative</td>
<td>8</td>
</tr>
<tr>
<td>2 Importance of non-judgmental feedback</td>
<td>8</td>
</tr>
<tr>
<td>3 Open person-centered questions as being important</td>
<td>6</td>
</tr>
<tr>
<td>4 Use of wait time</td>
<td>4</td>
</tr>
<tr>
<td>5 Assessment can take place at anytime during instruction</td>
<td>3</td>
</tr>
<tr>
<td>6 Creating friendly and conducive classroom atmosphere</td>
<td>1</td>
</tr>
<tr>
<td>7 Importance of self and peer assessment</td>
<td>1</td>
</tr>
<tr>
<td>8 Existence of other assessment methods other than oral questioning</td>
<td>1</td>
</tr>
</tbody>
</table>

From the reflections all the teachers expressed their awareness of two different types of assessment (formative and summative) and the differences between them, stating that prior to the workshop they never knew that there were two types of assessment. This shows that even though the teachers, both trained and untrained, used aspects of formative assessment in their lessons they were not explicitly aware of the concept of formative assessment. The reflections also showed that the teachers acknowledged the strength of formative assessment and the formative assessment cycle in improving student learning. Three of the teachers noted that they had come to know that assessment is an activity which could take place at any time during instruction instead of taking place only after instruction. This confirmed their lack of awareness about formative assessment at the beginning of the research process. Annabel expressed this in the following excerpt from her reflection:
Annabel: I learnt so many new ideas, and really counted myself very fortunate to have participated .... Firstly, I understand what formative assessment is all about and that it is very necessary and effective in the classroom. I came to know about the formative assessment cycle. I also discovered that if the formative assessment approach is well applied, there will be a great improvement in the student’s understanding, leading to good results. ... it is very vital and reflects the aims of learning, and is used in making decisions about the next steps in (student) learning unlike summative assessment, that is also very important but is done at the end of a lesson taught topic or term, to assess students understanding.

Collection of Assessment Information

With respect to the collection of information about student learning the teachers appreciated the use of open-person centered questions, with six out of the eight participants making positive comments about this type of questioning. Lucas had this to say:

Lucas: Before this workshop, I used to know a question was a question. I never knew there were better questions than others. But now, I find things much easier for me and for my students. I know what it means collecting evidence of student thinking, interpreting it and leading the student towards a particular goal.

Annabel was even more explicit in her reflection:

Annabel: I have really learnt much about questioning - that there are different types of questions: subject-centered, person-centered, process-centered, and others questions, and also how to go about asking them. I also understood, and saw that person-centered questions are the most important of questions to be asked and that they can be open or closed. Open ones are more effective and most useful in the classroom. Since I have learnt a lot about effective questioning I am going to apply the various ways of questioning, and try as much as possible to focus on open person-centered questions.

Half of the teachers mentioned the importance of observing wait time but did not give any in-depth explanations on why they thought it was important or what role it will play
during instruction. Annabel expressed relief at knowing that there are other methods of collecting information about student learning which she could use other than oral questioning.

**Teacher Feedback**

All the teachers mentioned the importance of non-judgmental feedback. This was an aspect that drew a lot of comments from the teachers showing their initial lack of about the use of judgmental feedback. During the lesson planning and implementation period there was considerable improvements with respect to the use of judgmental feedback. This is how Paul described his giving of feedback before the workshop:

**Paul:** I was used to comments like wrong, bad, and suicide mission. In short, a lot of comments that were discouraging, but after the assessment workshop I felt guilty with all these comments I used to make. I am going to avoid comments as much as possible that could demoralize the students or others. This point is very important because the type of comments teachers give in class determines the fate and success of that class. I will reiterate here that this is one of the most important benefits of the workshop since comments can also destroy the morale in class as students will always be afraid to talk in class because their answers will be used to ridicule them.

The comments focused mainly on feedback with respect to oral questioning. This was expected as oral questioning was the dominant method of collecting information about student learning. Paul, however, discussed the importance of using comments-only marking as opposed to grades-only which he initially practiced.
Difficulties

Table 33 shows the different types of difficulties the teachers experienced during the lesson planning and implementation phase and which they thought could obstruct their use of formative assessment.

Table 33

Difficulties Expressed by the Teachers

<table>
<thead>
<tr>
<th>Difficulty</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Large class size</td>
<td>8</td>
</tr>
<tr>
<td>2 Lack of laboratory/facilities especially for junior classes</td>
<td>8</td>
</tr>
<tr>
<td>3 Time constraints in the use formative assessment</td>
<td>3</td>
</tr>
<tr>
<td>4 Apprehensiveness and difficulty in changing or adapting to new concepts such as person-centered questioning, wait time, etc.</td>
<td>3</td>
</tr>
<tr>
<td>5 Lack of knowledge in areas such as inquiry, group formation and classroom management</td>
<td>2</td>
</tr>
<tr>
<td>6 Very little teacher motivation</td>
<td>1</td>
</tr>
</tbody>
</table>

Each participant saw large class size as being a major obstacle to their use of formative assessment. This was expected as the teachers now understood that through formative assessment practices they should be able to individualize and target instruction as well as providing more tutoring to the students (Yeh, 2006).

Also emerging as an important constraint to the teachers was the lack of resources for use in the planning and teaching of lessons involving formative assessment. This was acute in the junior classes which are not allowed access to the laboratories. Though the lack of teaching and learning resources may hinder the teachers' involvement of students
in hands-on and group activities, thereby depriving of them of the opportunity to assess each other's learning, the researcher felt that the teachers lacked the skills and knowledge on how to improvise and use local resources. The teachers only thought of teaching resources in terms of western-styled equipment. Though the teachers were given the opportunity to look for any resources they needed for the lessons, they did not fully use this opportunity. They did not use the wide range of locally available materials or resources from other sources such as other schools and resource centers. They did not get all the materials that they would have used in the lessons but yet failed to use all the money and opportunities provided to obtain the materials. In one of the lessons (group 2, lesson 2), the teacher involved the students in looking for the materials by asking them to bring locally available materials from their homes, which in the researcher's opinion provided a good avenue to obtain large quantities of materials for student use. Thus the absence of adequate hands-on activities appears to be more of an issue of the teachers lacking the experience to improvise or the belief that there can be no science learning without western type of equipment. Lack of training or poor teacher training, according to Muwanga-Zake (1988), is responsible for teachers not knowing what to do and so resort to reliance on textbooks and the practice of chalkboard teaching.

Three out of the eight teachers described the use formative assessment as needing time as concerns the planning and implementation of lessons. In addition to this Fiona also saw the need for more time for meetings to discuss and exchange ideas about aspects of formative assessment with other teachers. Generally, this situation is aggravated by the fact that in such high stakes testing systems, such as that found in Cameroon, teachers are faced with extensive curriculum and reporting requirements (OECD, 2005). With the
teacher and school’s credibility depending on the students’ performances on standardized tests, the teachers tend to use traditional teaching approaches that permit them meet the different curriculum requirements. With the school year divided into five main testing periods (sequences), much time is lost in planning and reporting of students’ performances in summative tests. This places the teachers under considerable time pressure as they struggle to meet the requirements of high stakes testing.

Though mentioned by just two out of the eight participants, the lack of knowledge of inquiry teaching and associated aspects could be a serious barrier to the teachers’ use of formative assessment. Considering the link between formative assessment and inquiry, and the fact that teachers generally lack the skills to plan interactive classroom activities, it is obvious that their students are hardly involved in collaborative activities which could provide opportunities for peer assessment. With the lack in required knowledge, the teachers do not feel confident enough to engage their students in aspects of formative assessment. As such they tend to rely on traditional forms of teaching which are void of the challenges of open-ended, student-centered activities that are often part of formative assessment. As can be seen from the table two of the participants expressed the fear of using to some aspects of formative assessment as they can result in classroom management problems. For some of them, some of these concepts are just too new and not easy to easily understand.

**Teacher Recommendations**

Table 34 shows that the list recommendations can be split into two main categories: one category having to do with professional development and the other about
the provision of resources to facilitate the use of formative assessment in their classes. The teachers recommended more workshops and training not only in the area of assessment but also in other areas of science education. Interestingly, one of the participants recommended assessment training to be not only for teachers but also for administrators. This is could be an important recommendation because, as stated by Stiggins (2002), teachers may turn to administrators for help in using formative assessment but competence in assessment has never been a requirement for licensing as a principal or school administrator. Popham (2009) also supports the idea that assessment literacy programs specifically tailored for administrators should exist.

Table 34

Recommendations

<table>
<thead>
<tr>
<th>Recommendations</th>
<th>Category</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 More teacher workshops and training for teachers</td>
<td>Professional</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Development</td>
<td></td>
</tr>
<tr>
<td>2 Provision of teaching aids</td>
<td>Resources</td>
<td>5</td>
</tr>
<tr>
<td>3 Provision of science preparatory room for teachers</td>
<td>Resources</td>
<td>2</td>
</tr>
<tr>
<td>4 Access to laboratory for junior students</td>
<td>Resources</td>
<td>2</td>
</tr>
<tr>
<td>5 Reduction of class size</td>
<td>Resources</td>
<td>2</td>
</tr>
<tr>
<td>6 More collaboration and planning with other colleagues</td>
<td>Professional</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Development</td>
<td></td>
</tr>
<tr>
<td>7 Contacts and links with teacher training schools</td>
<td>Professional</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Development</td>
<td></td>
</tr>
<tr>
<td>8 Financial support to teachers</td>
<td>Resources</td>
<td>1</td>
</tr>
<tr>
<td>9 Assessment and other training for administrators</td>
<td>Professional</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Development</td>
<td></td>
</tr>
</tbody>
</table>
Summary of Lesson Planning and Implementation Process

The lesson planning and implementation phase showed considerable change in the lesson format from the 'review-lecture-note-taking' format to a 'review of prior knowledge-activities-summary/review-assessment' format. Some form of assessment could be seen in most phases of the lessons coupled with more student activities. Collection of assessment information was, however, done mostly through oral questioning with subject-centered questions forming the greater part of the questions. The use of open, person-centered questions showed just small improvements. The lessons more planned questions and the use of wait time of 3 or more seconds increased to over 50% in most of the lessons. One of the remarkable improvements in these lessons was a significant reduction in the use of judgmental responses from teachers to students' responses. Judgmental feedback could be observed in less than 15% of the teacher responses. Though the lesson had increased student activities, organization and implementation of these activities showed lack of skill on the part of the teachers. The groups were often large with little guidance to the students and involved short and ineffectively managed discussion periods. This made student involvement in the assessment process still weak.

Group discussions with the teachers indicated that they understood the concept formative assessment and use of formative assessment cycle as they were able to identify and comment on the presence or absence of different aspects of formative assessment in the lessons. This could be corroborated from their reflections about the importance and use of formative assessment, difficulties in its implemented and the type of help needed. The teachers not only emphasized the need for reduction in class sizes and availability of
teaching resources but recommended the need for training in aspects of assessment and inquiry. Top on their list of recommendations was the provision of training.

The Follow-up Phase

Each of the 8 participants chose and planned a lesson to teach on their own during the Fall term. This part of the study was to provide information as to how each teacher understood and implemented the formative assessment in their lessons. Only seven of the teachers took part in this phase of the study as Annabel changed jobs and was no longer available.

Lesson Plans

The different lesson plans were read and checked for their inclusion of various aspects related to formative assessment. These included lesson objectives, identification of prerequisite knowledge, planned student activities, planned assessment methods, and planned feedback. Table 35 summarizes these aspects for the all teachers. Six of the seven participants had clearly written objectives, planned activities and assessments for their lessons. Martha did not have a lesson plan. She had just her lesson notes without objectives and activities. Four of the teachers (Lucas, Tim, Nathan and Fiona) indicated the prior knowledge needed for the lesson and how they will confirm if the students had this knowledge or not. Only Paul stated that he will take time to give students feedback after the end of lesson assessment activity. The lesson plans indicated that oral questioning was going to be the widely used assessment method. Three of the seven teachers indicated the possible use of group activities. With six of the seven teachers of
the teachers stating the lesson objectives as well as planned activities and assessment incidents, this was a probable indication of their ability and willingness in using the formative assessment cycle. They were able to carry out all these planned activities during the lessons. The indication of planned oral questions throughout the lesson was also a sign of the teachers having an understanding that assessment does not only take place at the after instruction but also during instruction. The lesson plans show the knowledge acquired by the teachers and may not reflect a total change in views as it may just be temporal or just to satisfy the researcher. Observation of the teachers over longer periods of time could yield a better conclusion on their continuous use of the different aspects of formative assessment.

Lesson Observations

Each of the seven teachers was observed as they taught the planned lessons. Table 36 summarizes the four main areas of formative for all the seven lessons.

Use of Formative Assessment Cycle

All the teachers showed understanding of the concept of formative assessment and the formative assessment cycle. They all stated the objectives of their lessons, though in the cases of Daniel and Martha, the objectives were stated in passing with no emphases. The teachers, except Nathan, did not relate feedback to learning objectives. This means that though many teachers are beginning to share lesson objectives with the students at the beginning of lessons, they are still not able to go further by making it an integral part of the whole lesson by constantly returning to it and reminding the students.
<table>
<thead>
<tr>
<th>Participant</th>
<th>Stated Objectives</th>
<th>Prerequisite Knowledge</th>
<th>Planned Materials and Procedures</th>
<th>Planned Assessment Methods</th>
<th>Planned Feedback</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daniel</td>
<td>Clearly stated</td>
<td>Not stated</td>
<td>Elaborately planned activities</td>
<td>Oral questioning with planned end-of-lesson questions</td>
<td>Not mentioned</td>
</tr>
<tr>
<td>Lucas</td>
<td>Clearly stated</td>
<td>Stated</td>
<td>Elaborately planned activities</td>
<td>Oral questioning, writing of lesson report</td>
<td>Not mentioned</td>
</tr>
<tr>
<td>Tim</td>
<td>Clearly stated</td>
<td>Stated</td>
<td>Elaborately planned activities including diagrams</td>
<td>Oral questioning with planned end-of-lesson questions, group work,</td>
<td>Not mentioned</td>
</tr>
<tr>
<td>Nathan</td>
<td>Clearly stated</td>
<td>Stated</td>
<td>Elaborately planned activities with side notes</td>
<td>Oral questioning with planned end-of-lesson question, group work,</td>
<td>Not mentioned</td>
</tr>
<tr>
<td>Paul</td>
<td>Clearly stated</td>
<td>Not stated</td>
<td>Elaborately planned activities including diagrams</td>
<td>Oral questioning throughout lesson</td>
<td>Guiding students to answers of questions</td>
</tr>
<tr>
<td>Fiona</td>
<td>Clearly stated</td>
<td>Stated</td>
<td>Elaborately planned activities</td>
<td>Oral questioning, group and whole class, discussion, quiz and homework</td>
<td>Not mentioned</td>
</tr>
<tr>
<td>Martha</td>
<td>Not Stated</td>
<td>Not stated</td>
<td>Not stated</td>
<td>Not stated</td>
<td>Not stated</td>
</tr>
<tr>
<td>Participants</td>
<td>Formative Assessment Cycle</td>
<td>Information Gathering</td>
<td>Feedback Type</td>
<td>Student role</td>
<td></td>
</tr>
<tr>
<td>--------------</td>
<td>----------------------------</td>
<td>-----------------------</td>
<td>---------------</td>
<td>--------------</td>
<td></td>
</tr>
<tr>
<td>Daniel</td>
<td>Implicitly stated objectives followed by well planned activities and assessment at end of lesson</td>
<td>Oral questioning</td>
<td>Oral and non-judgmental with hints and scaffolding</td>
<td>No evidence of peer or self assessment, students only took part in demonstrations</td>
<td></td>
</tr>
<tr>
<td>Lucas</td>
<td>Stated objectives clearly as in lesson plan, planned activities and assessments</td>
<td>Oral questioning</td>
<td>Oral and non-judgmental, accepting all answers</td>
<td>No evidence of peer or self assessment</td>
<td></td>
</tr>
<tr>
<td>Tim</td>
<td>Evidence of formative assessment cycle: implicitly stated objectives followed by checking of prerequisite knowledge and well planned activities and assessment</td>
<td>Oral questioning, Group and whole-class discussion, and Homework</td>
<td>Oral, non-judgmental, with frequent use of hints, cues and prompts</td>
<td>Brief group discussions and whole-class discussion most of the time</td>
<td></td>
</tr>
<tr>
<td>Nathan</td>
<td>Stated objectives clearly as in lesson plan, planned activities and assessments, reminding students of lesson objectives</td>
<td>Use of oral questioning, student observation and whole class discussion</td>
<td>Oral, non-judgmental, which involved providing students with hints, cues and prompts</td>
<td>Students worked and discussed in groups</td>
<td></td>
</tr>
<tr>
<td>Participants</td>
<td>Formative Assessment Cycle</td>
<td>Information Gathering</td>
<td>Feedback Type</td>
<td>Student role</td>
<td></td>
</tr>
<tr>
<td>--------------</td>
<td>----------------------------</td>
<td>-----------------------</td>
<td>---------------</td>
<td>--------------</td>
<td></td>
</tr>
<tr>
<td>Paul</td>
<td>Stated objectives clearly as in lesson plan, planned activities and assessments</td>
<td>Oral questioning</td>
<td>Oral and non-judgmental</td>
<td>No evidence of peer or self assessment</td>
<td></td>
</tr>
<tr>
<td>Fiona</td>
<td>Evidence of formative assessment cycle: implicitly stated objectives followed by checking of prerequisite knowledge and well planned activities and assessment</td>
<td>Use of oral questioning, student observation and whole class discussion</td>
<td>Oral and non-judgmental</td>
<td>Pair and group work</td>
<td></td>
</tr>
<tr>
<td>Martha</td>
<td>Implicit objectives, no planned student activities</td>
<td>Oral questioning</td>
<td>Oral, non-judgmental, which involved providing students with hints, cues and prompts</td>
<td>None</td>
<td></td>
</tr>
</tbody>
</table>
In reviewing learning, Nathan was able to relate the activities to his stated objectives. In six of the seven lessons the teachers had planned activities that were used to collect information about student learning. Assessment activities were spread out throughout the lesson and not just at the end of the lesson.

**Collection of Assessment Information**

Oral questioning remained the common assessment method. Three of the seven teachers implemented some group activities in their lessons. The group activities, however, lacked proper organization and co-ordination. The large number of students and the lack of space greatly hindered the formation and functioning of the groups. In all three cases in which there was group work, the time given to students to carry out different activities was limited and whole class discussions were not elaborate or extensive. The teachers showed limitations in their organization and implementation of group work and inquiry activities.

As can be seen from Table 37, about half of the teachers’ questions were subject-centered. The use of person-centered questions showed an increase from a maximum of 30.5% in the lesson planning and implementation phase to 45.6%. Process-centered questions were not observed. Open questions also showed an improvement from a high of 44.1% in the lesson planning and implementation phase to 57.0%. They seem to be gradually seeing that questioning is not just about seeking the right answers and are starting to different types of questions accompanied with better use of wait time in initiating classroom dialogue. Wait times of three or more seconds showed an increase
from 61.8% in the lesson planning and implementation phase to 84.8%. Wait times of 10 or more seconds could even be observed in some of the lessons.

Table 37
Aspects of Oral Questioning from Individual Lessons

<table>
<thead>
<tr>
<th>Assessment Aspect</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subject-centered questions</td>
<td>50.6</td>
</tr>
<tr>
<td>Person-centered questions</td>
<td>45.6</td>
</tr>
<tr>
<td>Process-centered questions</td>
<td>0</td>
</tr>
<tr>
<td>Other types of questions</td>
<td>3.8</td>
</tr>
<tr>
<td>Open questions</td>
<td>57.0</td>
</tr>
<tr>
<td>Closed questions</td>
<td>43.0</td>
</tr>
<tr>
<td>Feedback</td>
<td></td>
</tr>
<tr>
<td>Non-judgmental</td>
<td>98.7</td>
</tr>
<tr>
<td>Judgmental</td>
<td>1.3</td>
</tr>
<tr>
<td>Wait time</td>
<td></td>
</tr>
<tr>
<td>More than 3 s</td>
<td>84.8</td>
</tr>
<tr>
<td>Less than 3 s</td>
<td>15.2</td>
</tr>
</tbody>
</table>

Teacher Feedback

The teachers avoided the use of non-judgmental feedback. The use of “no”, “yes”, “correct”, or “wrong” which were common at the beginning of this study was not observed. Non-judgmental feedback was only observed in one situation when the teacher used “no” in response to a student’s answer. Nathan, Tim and Lucas provided opportunities for multiple student views and encouraged students to state their own ideas. The following is a segment from Lucas’ lesson:

Lucas: What do you understand by the term carbohydrates?
Student: A compound containing carbon, hydrogen and oxygen.
Lucas: Let have another idea.

Student: Compound containing carbon, hydrogen and oxygen which are used to produce energy.

Lucas: Who has yet another idea?

This showed the teacher collecting students’ different answers without stating if they were wrong or correct. In other cases the teacher provided scaffolding which led the students to the correct answer without directly telling the student if the answers were correct or not.

Tim: What is a regular solid?

Student: Something that is straight.

Tim: Are all regular objects straight?

Student: No. Regular solids have a definite shape.

Though the teachers are beginning to accept multiple student views, there was still no evidence of the type of insightful feedback which could initiate substantial classroom dialogue and enable students to take the next steps in learning.

**Student Involvement in the Assessment Process**

The use of self and peer and assessments remained a rare occurrence. The teachers are still not providing opportunities for self and peer and assessment. Group work presented the only opportunity for the students to assess each other’s ideas as they could be seen discussing and exchanging views in the case of the three lessons in which there was group work but this was only in three of the lessons. The lessons showed little evidence of any other use of students in assessing their learning or that of their peers.
Teachers' Individual Reflections on the Follow-up Lessons

The teachers' reflections (from the questions on Appendix N) on their lessons were studied and the main themes extracted from them which are presented here. Their ideas are provided separately in this section so as to indicate their individual understanding of the concept of formative assessment.

Use of Formative Assessment Cycle

Lucas said he followed the formative assessment cycle since he started by stating the objectives of the lesson, then went ahead to collect evidence of student learning through oral questioning. He also said by having students at the center of the learning process, formative assessment was actually in use. From observing the lesson, it could be seen that the objectives were clearly stated and that student activities were planned. However, it was not clear what information was collected about student learning and how the information collected was used to modify the learning or instruction.

Nathan said he followed the formative assessment cycle because he clearly stated the lesson objectives and provided student activities. He thought that by observing and questioning the students, he was collecting evidence about their learning. This matched his lesson plan and what happened during the lesson. Nathan mentioned that he interpreted the information though it was not evident how he did so. He also thought by having the students carry out all the activities they were at the center of the whole learning process. Nathan’s statements showed an understanding of the essential aspects of formative assessment even if though some were not strictly implemented.
Tim said he followed the formative assessment cycle well. He mentioned that he assessed students' prior knowledge on regular solids before going on to state the objectives, and then proceeding to the new lesson on regular solids. This shows that he sees the importance of assessment at all phases of the lesson and not just at the end of the lesson or topic. Tim mentioned that by observing the students and helping them where they had difficulties and helping them attain the lesson objectives, he was making the formative assessment cycle complete. He was actually able to help one of the groups by discussing the procedure with them when they had problem continuing with the investigation.

Paul said that by stating the lesson objectives and using them to guide student learning he was following the formative assessment cycle. He, however, made no mention of how exactly how the collected information was used in guiding student learning.

Daniel, on his part, said he applied the formative assessment cycle by assessing previous knowledge, followed by planned activities, during which he was able to use oral questioning to assess the students more. He did not say how the collected information resulted in subsequent class activities or what the link was between the assessment and the class activities. He also thought that by emphasizing the goals of the lesson he was putting formative assessment into play.

For Fiona, by stating the goals of the lesson and following up with planned activities carried out by the students she thought she was following the formative assessment cycle. She thought from the activities she could determine how well the
students were learning. She did not clearly indicate how she was able to gauge the level of student understanding.

Martha saw the assessing of previous knowledge as an important aspect of formative assessment though she was not able to connect this to the rest of the lesson.

**Collection of Assessment Information**

Lucas said he used mainly person-centered questions as the method of collecting information about student learning. He also thought that he adequately practiced the use of wait time during questioning. Analysis of the questions Lucas asked during the lesson showed that he used person-centered questions 55.5% of the times and used wait times of 3 or more seconds 88.8% of the times indicating he was becoming more conscious and making progress with questioning.

Nathan stated that he used group work and oral questioning as the main evidence collection methods which is what actually happened during the lesson. He also mentioned the assessment of students’ prior knowledge which he used to introduce the lesson. He did performed two demonstrations which were used to introduce the concept of physical and chemical changes. He was able to use the students’ prior knowledge to help them in learning.

Tim said he used oral questioning and group work as the main methods of gathering information about student learning. He thought most of the questions used were open and person-centered, and that he made a conscientious effort to observe good wait time. Analyses of his questions showed that 56% were open-ended while 44% of them were person-centered, 38% were subject-centered questions and 0% was process
questions. Study of the wait times show that for 88% of the questions wait time was more than 3 seconds. Tim thought group work provided an important information collection avenue in that he could see what they were doing as well as hear what they were saying during the discussions. He thought using the ideas from all of this helped him proceed to achieve the objectives. This showed considerable understanding of the formative assessment cycle on the part of Tim.

Paul said student responses to oral questions provided the information about student learning. Paul also mentioned that he used a combination of demonstrations, by a few students, and whole discussions instead of group work due to the large size of the class. He did actually have two pairs of students demonstrate experiments to the whole class and this was followed by open questions whereby he asked students to give reasons for their observations. Through this he was able to build and conclude on the main ideas of the lesson.

Daniel stated that he observed students as they carried different activities, using oral questioning to find out more about their understanding and reasoning. He did not say how he used the information to help students in their learning.

Fiona said she used a variety of methods to collect information about student learning which is what she actually did in her lesson. She used group and whole-class discussion, oral questioning, a quiz, and assigned homework. She was able to use the variety of methods to collect students’ ideas, modify them, and conclude on the lesson.

Martha said she used oral questioning as the means of collecting information about student learning. This was actually the only method she used as there were no
planned activities. The lesson was carried out through direct instruction interspersed with many questions.

**Teacher Feedback**

Lucas indicated that he used oral feedback which was non-judgmental by avoiding the use of comments such as ‘good’, and ‘bad’. He also mentioned that he considered all students’ opinion as being important in developing the lesson. This showed an improvement for Lucas who prior to the workshop gave personal judgmental feedback to the students. He mentioned the assigning of grades on student reports. This showed tendencies of using summative assessment.

Nathan mentioned that the feedback was both oral and non-judgmental. He said he used comments only feedback which was not evident as the students did not do any paper and pencil assessments.

Tim stated that he gave oral and non-judgmental feedback. He was not able to elaborate on the feedback and how it helped the students.

Paul saw his feedback as being oral and non-judgmental. He said by using many follow-up questions, without saying the answer was right or wrong he was giving a chance for more ideas and creating a non-threatening environment. This was particularly interesting as this comment was coming from someone who at the beginning of the study used very judgmental comments indicating a shift in views and practice. He had learned to stay quiet without commenting on students’ answers thus giving an opportunity for others to answer.
Daniel thought feedback was mostly non-judgmental because for most of the responses he remained silent or asked follow-up questions. He did actually try to stay quiet or asked follow-up questions.

Fiona said the feedback to oral questions was non-judgmental and immediate while for the quiz and homework it was not immediate as she had to look at them before handing them back to the students.

Martha mentioned the use of oral and written comments as the type of feedback she used in the lesson. However, no written comments were observed as there was no paper and pencil assessment during the lesson.

**Student Involvement in the Assessment Process**

Lucas said he could observe students discussing their ideas during the lesson. However, there were no planned instances for students to discuss their ideas.

Nathan mentioned that the students were able to assess themselves and their peers through the different group activities. He said commenting on each other’s answers during group work constituted peer assessment. Group work in his Nathan’s lesson was well organized and co-ordinated.

Tim said the students worked effectively in their groups and he could see peer assessment when the students commented on each other’s ideas or during whole-class discussions when they commented on the ideas of other groups. Students were able to share ideas with the whole class and comment on others’ observations and conclusions. The groups were rather large and made the co-ordination of the group work by the teacher difficult.
Paul thought there was a lot of self assessment as he allowed the students to reflect on their answers thereby promoting self assessment and by giving a chance for students to comment on other students’ answers, peer assessment was in play. However, this could not be seen during the lesson. Communication in the lesson was essentially between the teacher and individual students and little communication took place between the students.

Daniel stated that by the students discussing amongst themselves they were able to assess each other, thereby learning from each other. It was not clear how he came to this conclusion.

Fiona said the use of group work gave an opportunity for the students to assess themselves. She said each student had the opportunity to give an opinion and was also able to critique their colleagues.

Martha stated that by having to ask questions they were assessing themselves. It was obvious she did not quite get the point about peer and self assessment.

Table 38 presents a summary of the main points from the teachers’ reflections. The reflections show varying degrees of understanding of the use of the different aspects of formative assessment. Overall the teachers understand they have to collect information about student learning, interpret it and use to improve learning. How exactly they have to implement seems to be the where the hurdle is for some of the teachers as they are not able to clearly say how this can be done.
<table>
<thead>
<tr>
<th>Formative Assessment Cycle</th>
<th>Assessment Information</th>
<th>Teacher Feedback</th>
<th>Student Involvement</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Lucas</strong></td>
<td>He said he used mainly person-centered questions. Analysis showed he used person-centered questions 55.5% of the time and 88.8% of good wait time.</td>
<td>He indicated the use of non-judgmental oral feedback and considered all students' opinion important which was an improvement as prior to the workshop he used judgmental feedback.</td>
<td>Lucas said he could observe students discussing their ideas during the lesson. However, there were no planned instances for students to discuss their ideas.</td>
</tr>
<tr>
<td><strong>Nathan</strong></td>
<td>He said he used group work and oral questioning as the main evidence collection methods which is what he did.</td>
<td>Nathan stated that he used oral, non-judgmental feedback and comments only feedback. Comments only feedback was not evident as there were no written assessments.</td>
<td>He mentioned that students were able to assess themselves and their peers through the different group activities. Group work was well organized.</td>
</tr>
<tr>
<td><strong>Tim</strong></td>
<td>He thought most of the questions used were open and made good use of wait time. Analyses showed that 56% were open-ended and 88% of questions had good wait time.</td>
<td>Tim said he gave oral and non-judgmental feedback but was not able to elaborate on the feedback and how it helped the students.</td>
<td>Tim said as students worked in groups he could see peer assessment. Students did share ideas and commented on each others' observations.</td>
</tr>
<tr>
<td>Formative Assessment Cycle</td>
<td>Assessment Information</td>
<td>Teacher Feedback</td>
<td>Student Involvement</td>
</tr>
<tr>
<td>----------------------------</td>
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</tr>
<tr>
<td>Paul</td>
<td>It was not evident how the collected assessment information was used.</td>
<td>He said he used student observation and oral questioning to gather information which is what he did.</td>
<td>Paul said feedback was oral and non-judgmental. He had actually learned to stay quiet without commenting on students’ answers.</td>
</tr>
<tr>
<td>Daniel</td>
<td>He did not say what the link was between the assessment and the class activities.</td>
<td>Stated the use of observations and oral questioning. Did not say how he used the information to help students.</td>
<td>Daniel said feedback was non-judgmental because he remained silent or asked follow-up questions. He did actually do that.</td>
</tr>
<tr>
<td>Fiona</td>
<td>She collected information about student learning but did not clearly indicate how she was able to use it to gauge the level of student understanding.</td>
<td>She said she used group and whole-class discussion, oral questioning, a quiz, and assigned homework which is what she did.</td>
<td>She said to oral feedback was non-judgmental and immediate while for the quiz and homework it was not immediate because she had to correct first.</td>
</tr>
<tr>
<td>Martha</td>
<td>She saw assessing of previous knowledge as an important aspect of formative assessment though she was not able to connect this to the rest of the lesson.</td>
<td>Martha said she used oral questioning as the means of collecting information about student learning</td>
<td>Martha mentioned the use of oral and written comments but no written comments were observed as there was no written assessment.</td>
</tr>
</tbody>
</table>
Summary of Follow-up Phase

The lesson plans and teaching of the follow-up lessons portrayed considerable awareness and use aspects of formative assessment. Teachers were able to state the objectives of the lesson at the beginning. They, however, did not revisit these objectives and link them to different lesson activities. This indicates those lesson objectives are still not an integral part of the whole lesson for them. The teachers used many student activities at many different phases of the lessons though strategies that invite and support student dialogue were still limited. Their use of a variety of assessment methods was still lacking with many of them struggling with group work and how to exactly use the assessment information which they collect. Oral questioning continued to be used as the main assessment method with a limited use of the other methods.

Feedback was generally oral and non-judgmental with major improvements in that most of the teachers used cues, hints, and scaffolding to push students to the correct answers unlike before when they would just say indicate if the answer was right or wrong. They still need to do more in providing more constructive feedback that help student easily take the next step to towards learning goals. The teachers provided the students with few opportunities for self and peer assessment which could be a good opportunity to save time as the classes are large. Overall, the teachers reflections show they have a better understanding of formative assessment then before as they could explain their use of formative assessment aspects in their lessons though the failed in some cases to adequately explain how they would use the assessment information or why they did not use other assessment methods or get students more involved in the assessment process.
The follow-up lessons showed some improvements. For example, the use of person-centered questions, and wait time considerably improved as compared to the lesson planning and implementation phase. However, the teachers thought they were doing a better job in some instances than the researcher thought. For example, all the teachers said they used the assessment information to help students in the learning process. Apart from Tim, the teachers did not say exactly how they used the information they collected and this was not also evident for the lessons observed. Also the aspect of peer and self assessment seemed to have been under-utilized though all the teachers thought by having some form of group activities it automatically meant the students were assessing themselves.
CHAPTER V

CONCLUSIONS AND IMPLICATIONS

Introduction

This chapter draws on the results presented in the previous chapter to answer the research questions. It also provides some implications with respect to theory, practice and policy. Particular emphasis is on the link between formative assessment, inquiry and teachers' pedagogical knowledge as a whole. Also of importance will be the role of formative assessment and professional development in supporting each other and the importance of policy in the implementation of formative assessment. Some limitations with respect to the study method as well as suggestions for further research are also presented.

Revisiting the Research Problem

Secondary teachers in Cameroon are not equipped to apply formative assessment in their classes. Over half of secondary teachers in Cameroon have no formal training. Even for those teachers with formal training, assessment training is often limited to a single course and focuses solely on the preparation and grading of tests and exams. This means that most teachers do not have the necessary skills to help students acquire deep learning through formative assessment. According to Kellaghan & Greaney (2004), some of the ways that teachers teach have been attributed to the assessment procedures that they use. A highly exam-oriented system, whereby, each student sits for the same national examination at the end of the course could greatly affect teaching methods.
Because Cameroon has a highly exam-oriented secondary education system, teaching and learning is often geared towards the end-of-course GCE. The result of this has been that teaching and assessment is largely limited to lower-level skills, focused mostly on content to be examined, or rely on drill methods. This situation has been made more difficult by large and unmanageable classes as well as the lack of or poor quality of teaching resources.

Faced with the constraints of lack of training, high stakes testing, large class size, and inadequate material resources, teachers do not often systematically collect information about students' learning which can help students move towards the attainment of desired learning goals. This study addressed the problem of lack of formative assessment in science classrooms in Anglophone Cameroon. The study explored 1) science teachers' initial views and practices as related to classroom assessment; 2) the changes that the teachers undergo in their use of formative assessment in their classrooms as they undergo professional development; 3) the difficulties the teachers face during the course of this process and the possible support needed in order for them to succeed. Data about teachers' assessment views was collected through a survey of 28 teachers and a group discussion about classroom assessment with a smaller group of 8 teachers. These 8 teachers, who formed the final study sample, were observed in their classrooms. From these observations, their initial practices as related to formative assessment were documented. Their views were also documented through individual interviews after the lessons. An orientation workshop was offered to the participants to acquaint them with the process of formative assessment as well as the lesson planning and implementation process that was to be used in the study. Two separate groups of
teachers then chose, planned, taught, revised, and re-taught a lesson. One member of the
group taught the planned lesson while the rest of the group and members of the second
took notes. At the end of each lesson (both when it was taught and when it was re-taught)
all those involved came together for a post-lesson discussion. From the teachers’ teaching
of the research lessons, discussions and reflections, changes in views and practice were
determined. Reflections provided an indication of the participants’ final thoughts on the
use of formative assessment for improving their students’ learning. Through all these
activities it was possible to explore the teachers’ shifts in perspective as concerns
formative assessment. A follow-up part of the study provides information on how the
teachers were able to sustain the newly acquired formative assessment skills.

Conclusions to Research Questions

Teachers’ Initial Views and Practice with Respect to Assessment

Teachers’ initial views of assessment showed awareness of a variety of
assessment methods. These included oral questioning, homework, quizzes, tests,
examinations and different class activities. The data showed that oral questioning, tests
and homework are the three most commonly used assessment methods. Apart from oral
questioning which falls in the personal communication category, the rest of the
assessment methods were in the paper and pencil category, with none in the performance
assessment category. The teachers held the view that assessment was more valuable at
particular times, such as the beginning and end of the lesson especially with respect to
oral questioning. For quizzes, tests and exams, they indicated administering them at
particular intervals which are often determined by the school administration and used
mostly for accountability purposes. Most of the teachers stated that classroom assessments give them an idea about student understanding of the science content with just a few of the teachers seeing assessment as providing information about student attitudes. The data also indicated that the teachers were aware of the use of the information from assessment to improve their teaching and student learning, collaboration amongst students, and to classify or group students.

The teachers' initial classroom practice showed little variety in activities. All the observed lessons showed the same format of 'review–lecture–notes-taking' with no hands-on activities. Of the assessment methods indicated by the teachers, oral questioning, assigning of homework and observation of students as they completed individual work were observed. There was very little of the other two methods of assessment. Oral questioning was the dominating assessment method. Few of the questions were open (15%), and person-centered (2%). Workshop activities on the writing of questions provided corroboration for this as 12.5% of the questions were person-centered. There was no sign of teachers' questions being planned as the concept in a particular question had no link with the concept in the next question. There was a lack of adequate wait time as only 2% of the teacher questions were followed by a wait time of 3 or more seconds. Though teachers had some basic ideas about formative assessment, the terms formative assessment and formative assessment cycle were new to all the teachers.

Using Tunstall & Gipp's (1996) classification, teachers initial views of feedback fell into the category of specifying attainment, which is the lower end of descriptive feedback, followed by the approval/disapproval category, which is purely judgmental.
Few teachers indicated using extreme judgmental feedback such as punishments. They also indicated not giving extreme descriptive feedback that could provide students with instructions on how to improve their work. Lesson observations showed that teachers’ views matched their practice as the teachers usually marked students worked using ticks and crosses to indicate right and wrong answers (specifying of attainment), or simply responding to students answers to oral questions with correct, wrong, no, or yes (approval/disapproval). There were, however, instances of extreme judgmental feedback where students were punished for not answering correctly or not answering at all. Workshop activities on provision of feedback provided triangulation as 62.5% of teachers’ feedback was judgmental and there was a lack of specificity with regards to the learning goals. In a few cases, teachers used the “try again” or “repeat-until-correct” feedback (Shute, 2008) which allowed students to build on their answers or other students’ answers till the correct answer was arrived at with no help from the teachers.

Student involvement in the assessment process was not commonly used. Teachers shunned group activities which enhance peer assessment citing lack of time or classroom management issues. In practice, there were little or no classroom activities that involved students. There were many missed opportunities as teachers failed to use student responses to initiate classroom dialogue.

**Changes in Teachers’ Views and Practice with Respect to Assessment**

Teachers’ views and practices with respect to formative assessment showed some changes during the professional development phase of this project. The teachers showed gains in their understanding of the concept of formative assessment and the key aspects
associated with it. From the planning of their lessons and reflections it was clear that they understood the importance of the formative assessment cycle. The new format in their lesson plans of 'review of previous knowledge–classroom activities–summary–review/assessment' indicated the teachers understood the importance of having assessment at all parts of the lesson instead of just at the beginning and end. Teachers’ review of previous knowledge at the beginning was linked to the lesson of the day instead of it just being a routine activity which may or may not have a link with the lesson of the day. Lessons had more student activities with students contributing more to the lessons and the teachers using students’ ideas to build on the lesson of the day.

Oral questioning, whole class discussions and observation of students as they completed different tasks were three common assessment methods used by the teachers. Oral questioning, however, remained the most used of the three methods. Teachers’ questioning skills showed some improvements. The teachers acknowledged learning that there were different types of questions, some of which can lead to better eliciting of ideas from students which they were not aware of before the workshop. Teachers’ use of person-centered questions ranged from a low of 19.4% to a high of 63.9% in the post-workshop lessons as compared to 2% in the pre-workshop lessons. The use of open questions showed an increase from the pre-workshop average of 15% to up to 57% in the post-workshop lessons. Wait time use showed a change from 2% in the post-workshop lessons up to 84.8% in post-workshop lessons. Teachers’ reflections showing this new awareness of different types of questions was placed among the three most important lessons learned from their involvement in this project.
Teachers’ responses to students’ answers also showed significant improvement. Non-judgmental responses varied between 81.8% and 100% in the post-workshop lessons as compared to 0% in pre-workshop lessons. The teachers stayed quiet, asked follow-up questions or provided hints instead of saying correct, wrong, no, or yes as was the case in the pre-workshop lessons. The use of punishments such as having students stand when they responded incorrectly to teachers’ questions was not observed in the post-workshop lessons. In a few instances the teachers could be observed providing hints and cues to different student responses to guide them to correct answers. But, in most cases teachers did not provide enough guidance to be useful. The aspect of feedback to students’ showed one of the major improvements for the teachers during the whole study process. The teachers’ reflections also indicated they considered this as one of the important aspects they learned from the process as it was rated second in terms of the important aspects that they learned. Overall, the teachers did not know how to effectively use the assessment information which they collected. In most cases when the teacher realized that the students did not attain the expected understanding, they simply restated their “original explanations louder and more slowly” (Guskey, 2003) instead of using alternative approaches or activities that could strengthen student understanding.

During the lesson planning and implementation phase as well as in the follow up lessons teachers included more student activities and group work than before. They, however, still had difficulties with the management of group activities. Classroom discussions and dialogue did not go far enough to result in fully interactive classroom environments. Considering that peer and self assessment can be time saving, especially in large classrooms, one would have thought that teachers would involve students more in
it. Whereas some form of peer assessment was observed during the different group activities, no form of self assessments was observed. The findings showed considerable changes in to the teachers’ use of some aspects of formative assessment and minimal changes in their use of other aspects.

**Difficulties Encountered by Teachers and Help Needed**

The teachers saw large class size and the lack of teaching materials as the greatest constraints in their use of formative assessment. The teachers felt that additional equipment, textbooks and other teaching resources could greatly facilitate their use of formative assessment. Before the lesson planning and implementation process, there was less emphases on constraints such as inadequate teacher skills and lack of time to effectively assess student learning. After the lesson planning and implementation, the teachers saw the lack of time, lack of skills and difficulty in adapting to new ideas such as formative as being crucial if they were to successfully use formative assessment.

Based on these views that the teachers held at the beginning of the lesson planning and implementation process, they were able to make recommendations towards their needs with respect to the use of formative assessment. Before the lesson planning and implementation process most of the teachers’ emphasis was on the provision of teaching aids such as laboratory equipment and books. These views seemed to change somewhat after the lesson planning and implementation phase. The most commonly mentioned needs, alongside the provision of teaching aids, was the provision of pedagogical skills not only in the area of assessment but also in other areas such as inquiry and classroom management. The teachers’ reflections also recommended training
not only for themselves but also for school administrators. Reduction in class size did not feature after the lesson planning and implementation phase as the biggest need for the teachers in their implementation of formative assessment. This may be because they realized it was going to be difficult to achieve a reduction in class size.

**Conclusions about Research Problem**

Formative assessment literate teachers understand that the main users of formative assessment are found in classrooms; are clear about achievement targets expected from students; are able to use the full range of assessment methods available to gather evidence about student learning; and finally use the assessment results to motivate students and improve learning (Stiggins, 2000). This study shows that in the context of chemistry teachers in Anglophone Cameroon, both trained and untrained teachers started with little knowledge and skills with respect to formative assessment. Providing them with the knowledge through a workshop and the opportunity to practice through lesson planning and implementation resulted in a shift in their formative assessment views and practice. This change, however, was not as expected with respect to all the aspects of formative assessment. Though the teachers showed understanding of the concept of formative assessment and the formative assessment cycle, the use of some of the aspects showed limited improvements. There was limited use of the variety of assessment methods available. Oral questioning, the most commonly-used assessment method, showed limited improvement in the use of closed and person-centered questions. On the other hand, aspects such as the use of wait time showed moderate improvement while response to students' answers showed significant improvement. The limited
improvements could also be attributed partly to lack of skills in particular areas and not enough time or opportunities to practice some of the newly gained ideas.

A comparison of the characteristics of effective professional development (Sparks & Loucks-Horsley, 1990) against the approach used in this study could show where possible shortcomings could have occurred. While the training went more than a one-shot workshop type of training, it did not go far enough to ensure considerable change in the teachers' practice. They may have acquired formative knowledge from the workshop, implementation lessons and related discussion, but did not have enough time and outside support in experimenting with the new approaches. The teachers' reflections indicated that they gained much knowledge in the workshops in particular. They acknowledged learning about formative assessment, its differences from summative assessment, the use of aspects such as open-person centered questions, wait time, and non-judgmental feedback to promote student learning. For aspects of formative assessment such as the use of wait time and the non-judgmental response to students' answers, which needed just changes in behavior, it was easy for the teachers to make some big changes. However, for aspects such as the planning and use of a variety of assessment methods and use of open, person-centered questions, the changes were not big enough and maybe more time and assistance could have helped the teachers in their use of these aspects. Also without involvement of the school administrators, and not having their own tailored training, the administrators did not get to play an important role in the professional development. According to Rogan & Grayson (2003), change in curriculum planning can be driven by professional and learning community based forces (change in response to professional imperatives and initiative of a critical mass of like-minded teachers) and a combination of
bureaucratic and leadership change forces. Therefore as the teachers organize and get ready for changing their formative assessment practice they need to be supported from leadership which was absent in this study process.

Though the teachers seemed quite grounded content-wise, they lacked the inquiry pedagogy which could facilitate the teaching of the chemistry content (Cuban, 2009) in this case. This indicates the importance of blending content knowledge with pedagogical knowledge in science teaching. This limitation in teacher knowledge and expertise when combined with conflicting beliefs and policies, administrative directives and other constraints such as the unavailability of resources results in what Cuban (2009) refers to as teachers “hugging the middle”. Teachers tend to use hybridized pedagogies by hugging the middle of teacher-centered and student-centered continuum.

The teachers in this study all claimed that lack of resources and large class sizes were the most important constraints preventing more use of formative assessment. However, there is reason to question this claim. Teaching resources are certainly important, but teacher skills are often considered to be more important in determining the degree to which good and successful teaching occurs in a given classroom (Wuwanga-Zake, 1998 in Wuwanga-Zake, 2010; Cuban, 2009). For example, in studies in South Africa, Wuwanga-Zake (1998) in Wuwanga-Zake (2010) discovered that most teachers ranked the lack of science equipment as the key problem in their teaching of science. He, however, discovered that in 16 out of 21 schools surveyed, most of the equipment could be “found gathering dust or neatly stored in boxes that have never been opened” (p. 3). Wuwanga-Zake discovered that this was because the teachers did not have adequate skills in using this equipment, the teaching of science or did not possess a proper understanding
of science itself. He mentions the fact that some teachers did not use the equipment or carry experiments because they did not feel confident about their practical skills and so prefer to use the lecture method as it seems to be an easy and faster way of preparing students for high stakes examinations. The teachers were provided with the opportunity to ask for materials needed for teaching, and they did not make use of this opportunity. A teacher resource center (TRC) was available where the teachers could get teaching materials and help on how to use. None of them sought this help from the teachers' resource center. TRCs were created with the help of the British Council to provide material and human support to clusters of schools. Schools are free to borrow materials for these centers and acquire help needed on how to use the equipment in teaching. Not having used any of these opportunities could have been due to reasons such as the teachers not knowing what exactly to ask for or they were not motivated enough to go for the equipment.

**Implications for Theory, Practice, and Policy**

**Formative Assessment within the Inquiry Cycle**

The National Science Education Standards (NRC, 2000) considers inquiry as being fundamental to science learning. Inquiry leads to actions as well as new questions. Based on these new questions next steps in learning have to be decided. In a sense, it is only through careful observation that the teacher can realize students' questions and decide on which steps to take. If the teacher is lacking the skills to plan the inquiry activities, it may be difficult to even discover students' difficulties and questions. This means that inquiry demands formative assessment (Carlson, Humphrey & Reinhardt, 2003).
Formative also demand inquiry as without proper inquiry formative assessment cannot be effectively implemented. Teachers, therefore, need both skills as part of their pedagogic repertoire of skills. One without the other may lead to difficulties in implementation. Having presented the teachers in this study with formative assessment skills and not inquiry skills may have been a reason why they were not able to fully apply the aspects of formative assessment in their lessons. Carlson, Humphrey & Reinhardt (2003) provide support for the formative assessment/inquiry process mirroring itself. They suggest that thinking of inquiry in the form of a cycle can help us understand the processes that students go through and the variety of activities that students engage in as they explore and come to understand the natural world. The learning cycle (Bybee, 1989) provides a useful way of how students engage in inquiry. Figure 11 shows the phases of this cycle: engagement, exploration, explanation, elaboration, and evaluation. Smith & Oliver (1996) provides a description of the learning cycle emphasizing the role of evaluation in each phase of the process. During the engagement phase the teacher poses a problem or focuses the students' attention on the topic. Evaluation (assessment in our case) in the engagement phase involves finding out the students' previous knowledge. During the exploration phase the students collect data that they can use to solve the problem that was posed. Evaluation in this phase focuses on how well the students are collecting the data. In the explanation phase, students use the data they have collected to solve the problem. Evaluation here focuses on how well students use the information they collected to form new ideas. In the elaboration phase, the teacher gives students new information or problems that extends what they have been learning in the earlier parts of the learning
cycle. Evaluation in this phase is when teachers have the students do the application problems.

![Learning Cycle Diagram]

Figure 12: The Learning Cycle (Bybee, 1989)

The NSES also considers assessment as an essential tool in science learning as it not only communicates expectations but provides operational definitions of what is important in science learning by the systematic collection and interpretation of data about student learning. Formative assessment then becomes important in inquiry-based classrooms as it offers a broader perspective on the rich learning called for by the Standards. It is also only through formative assessment that the NSES's changing emphases for assessment can be met as formative assessment assesses student understanding while at the same time having them engaging in the assessment process.

Carlson, Humphrey & Reinhardt (2003) placed a simplified version of the formative assessment cycle side-by-side the learning cycle and showed that at each phase of the learning cycle formative assessment techniques can be used to gather evidence about
student learning, make judgments about the evidence gatherer, and finally take steps to improve student learning. This is very similar to Smith & Oliver's (1996) description of the learning cycle. This shows that inquiry and formative assessment have a complementary relationship – each supporting the other. So as students undertake activities which can help in their understanding of the natural world (inquiry), the teacher is at the same time constructing an understanding of student learning (formative assessment). According to Carlson, Humphrey & Reinhardt (2003), inquiry needs formative assessment if it has to be successful and it is also only through properly organized inquiry activities that teachers can have information about student so as to decide on what steps to take.

![Figure 13: Formative Assessment within the Learning Cycle](image)

It can be said that inquiry and formative assessment are two important pedagogic skills which can help strengthen teachers’ pedagogical content knowledge as these skills can
help students not only have greater achievement but also have their learning monitored. The lack of inquiry skills could be a reason why the teachers in this study are not able to fully incorporate aspects of formative assessment in the lessons especially in the follow-up phase of the study where significant changes were expected but only moderate ones were observed. With teachers lacking in these skills professional development stands as the solution to the problem.

**Professional Development for (Formative) Assessment Literacy**

Faced with the problem of insufficient assessment skills it seems important to develop assessment literacy programs for teachers. Stiggins (2000) and Popham (2009) agree that such professional development programs should be tailored and specific. Stiggins (2000) proposes a “learning teams” approach to assessment literacy training. Under this model, teachers form small groups with opportunities to reflect, discuss and practice with respect to assessment. He proposes a combination of workshops, team work and individual study for assessment literacy programs. To start the program Stiggins proposes an introductory workshop session on assessment which could stimulate teachers and culminate in the formation of the learning teams. During these workshops expert provide the necessary guidance on assessment principles. Each team then decides to deal with particular assessment issues which they deem necessary. In addition to the workshops and team work there a heavy reliance on individual study is recommended whereby individual teachers work on agreed tasks to improve their knowledge and skills on assessment. As the team completes a learning cycle or experience they are able to share this with a larger group. This approach matches the knowledge base approach used
in this study in that the teachers assume responsibility for improving the practice. More so the training is on the spot offering a lot of flexibility as members decide to work when appropriate and accordingly create the time for it. This approach meets the requirements of professional development programs proposed by Loucks-Horsley, Stiles & Hewson (1996) and Loucks-Horsley & Matsumoto (1999) which calls for professional training to be specific, participant-centered as well providing opportunities for collaboration and practice year-long or over sustained periods. The learning teams approach also provides a bottom-up approach to professional rather than the usual top-bottom approach as teachers within a small group can motivate others and spread the practice of formative assessment within a whole school or region resulting to a change in practice. Miles et al’s change process can be used. In the initiation phase, a group of individuals decide to embark on assessment training leading to the formation of learning teams which engage members in bringing about change. Once the process gains support it can then move beyond the implementation phase to an institutionalization one by becoming school-wide or region wide. The advantage with this model of training is that it can be used not only in well-resourced schools but also in settings with limited resources. It is particularly advantageous as teachers do not have to travel long distances or abandon their classrooms as has been the case in Cameroon and other African countries to receive training. This greatly reduces the logistical problems associated with displacing the teachers and that of time lost in travelling. It can work for professional development as a whole and not only for professional development aimed at assessment literacy as teachers can decide what their needs are and follow similar procedures.
Teachers plan new tasks, adjust pedagogy to help students move towards desired goals

Teachers carry activities with students, providing specific student guidance

Teachers self-reflect on practice, rethinking goals, tasks, etc. - in collaboration with colleagues

Teachers collect evidence about their own practice – by videotaping lessons or observation by colleagues

Figure 15: Proposed Trajectory of Teacher Formative Assessment Change

Policy and Implementation of Formative Assessment

To make meaningful changes in the use of formative assessment to improve student learning, there need to be a strengthening of the different strategies that can be used in the classroom (Black & Wiliam, 1998b; OECD, 2005) through initial teacher education or professional development. Strong policy is needed to achieve this strengthening of formative assessment practice. If there isn’t proper policy in place the suggested bottom-up approach will lack the support it needs to flourish. Different countries or regions are using different ways of improving the implementation of formative assessment. For Black & Wiliam (1998b), the starting point has to be the recognition that formative assessment has its primary focus on the improvement of learning in the classroom. Concerning policies and programs, Gallagher & Worth (2008)
state that in the state of Arkansas, in the United States formative assessment has been fostered because:

... State laws (Act 999) requires the development of student academic improvement programs for students who fail to demonstrate proficiency in reading, writing, and math using results from progress of learning Strategies. The Arkansas Department of Education’s Rules Governing the Arkansas Comprehensive Testing, Assessment, and Accountability Program also requires formative assessment strategies used in student academic improvement plans to be included and revised periodically. The department’s Rules Governing Professional Development specifies that teachers form learning teams and develop common formative assessments (p. 24).

Among the types of support available for teachers, Gallagher & Worth (2008) state that:

... in the Rules Governing Professional Development, the Arkansas Department of Education grants professional development time for developing assessments for learning. It lists formative assessment as an approved topic for professional development so that teachers can learn to develop, interpret, and use formative assessments in each subject area and develop common formative assessments.

... through a collaborative project with the University of Arkansas, the Arkansas Department of Education supports state teachers through its Enterprise Guide for Educators, which guides them in accessing data for use in the improvement of classroom instruction (p. 28).

This could as well serve as a starting point for education policy makers in the case of Cameroon. A policy document on assessment will also need to make assessment literacy mandatory for all teachers and specify the assessment competency profile for both teachers and school administrators (Arlidge at al. (2000). Experts in the Ministry of National Education, universities and other education agencies could be charged with putting together an assessment resource kit will provide the literature and materials to guide the implementation of formative assessment especially for in-service professional development programs. Following Stiggins (2000) assessment literacy approach, subject advisers in each region could be charged with the organization of introductory workshop sessions from which point teachers in various schools could form learning teams. The activities of these learning teams could then be regularly evaluated by the school
administration and regional subject advisers. In this way a top-bottom approach is blended with a bottom-top approach to professional development resulting in shared responsibility.

Policy document from Education Ministry

Support/resources from Pedagogic Advisers & Universities

Attainment of Assessment Literacy

Implementation and institutionalization

Formation of assessment learning teams

Figure 16: Suggestion for Attainment of Assessment Literacy in Cameroon

Limitations

As with other studies involving the case study methodology, there were concerns about the reliability of the data collection methods and validity of the different findings. As a safeguard, the same four assessment aspects were used throughout the study. Also, the first ten responses to the initial questionnaire administered to students were checked by two people to see if it did actually collect the data it was intended to collect. The use of many different methods helped in triangulating the data.
Time was a big limitation as I could not spend more time on the field due to my teaching engagements and differences in the school periods between the United States and Cameroon. This was further compounded by the long distance and financial constraints which made frequent travels impossible.

Lastly, the use of a small study sample means there has to be caution in the generalization of some of the findings to the whole of Anglophone Cameroon.

Further Research

Further studies will be needed to determine the effectiveness of the learning teams approach to formative assessment. We need to understand the constraints that will be encountered using this approach. Through yearlong studies a number of learning teams can be followed on their journey through the assessment literacy training process. It is only then we can have a good picture of the suggested approach. In doing this action research could be conducted within different learning teams on specific aspects of formative assessment. These studies will focus on the implementation of aspects of formative assessment such as the use of various evidence collection methods, teacher feedback, and self and peer assessment. One team could focus on the implementation of novel assessment methods to explore their effectiveness and effects on student learning. Another group may look at how different forms of feedback affect student learning while another group may concentrate on the how peer and self assessment help in improving student achievement.

It is only through such on the spot classroom studies that we can slowly document the effectiveness of different formative assessment strategies while at the same time
improving teacher practice. With stronger policy on assessment in place to support such initiatives we will be building stronger bridges between research, practice and policy itself (OECD, 2005) through which the dream of assessment literacy for all teachers can be realized and student learning improved.
REFERENCES


Appendix A

HSIRB Approval Letter
Date: February 15, 2008

To: Herb Fynaweaver, Principal Investigator
   George Akorn, Student-Investigator for dissertation

From: Amy Naugle, Ph.D., Chair

Re: HSIRB Project Number: 08-01-28

This letter will serve as confirmation that your research project entitled "Enhancing Science Teachers' Assessment for Learning Skills through Lesson Study" has been approved under the expedited category of review by the Human Subjects Institutional Review Board. The conditions and duration of this approval are specified in the Policies of Western Michigan University. You may now begin to implement the research as described in the application.

Please note that you may only conduct this research exactly in the form it was approved. You must seek specific board approval for any changes in this project. You must also seek reapproval if the project extends beyond the termination date noted below. In addition, if there are any unanticipated adverse reactions or unanticipated events associated with the conduct of this research, you should immediately suspend the project and contact the Chair of the HSIRB for consultation.

The Board wishes you success in the pursuit of your research goals.

Approval Termination: February 15, 2009
Appendix B

Consent Form 1
Enhancing Science Teachers' Assessment for Learning Skills through Lesson Study

Western Michigan University, Mallinson Institute of Science Education
Principal Investigator: Herb Fynewever, PhD
Student Investigator: George Akom

I am invited to participate in a research project entitled, "Enhancing Science Teachers' Assessment for Learning Skills through Lesson Study". This research is intended to examine and improve science teachers' assessment for learning views and practices through lesson study. The study is George Akom's doctoral dissertation and may be published or presented at professional meetings.

I will be asked to participate in group discussion on classroom assessment to assess my initial views of assessment. I will also be observed as I teach two 50 minute lessons over period of two weeks which will be followed by a 45 minutes interview concerning my assessment views and practices. I will take part in a one-day orientation workshop on classroom assessment and lesson study practices. This will prepare me as I participate in the planning, teaching, and re-teaching a research lesson of 50 minutes duration, over a period of two weeks. Each of the two research lesson will be followed by post-lesson discussions of about 1 hour each.

As in all research, there may be unforeseen risks to the participant. If an accidental injury occurs, appropriate emergency will be taken. However no compensation or treatment will be made available to me. I am, however, not aware of any physical or economic risks that might result from my participation in this study. In the case of any discomforts, inconveniences, or apprehensions on my part, I will tell the researcher. Efforts will be made to avoid any conflicts in my usual schedules during all planning as this will require extra time. None of the activities I will be involved in will be disclosed to my principal or any administrator but the research group will be willing to share the final results of the study with them.

This study will permit me to reflect and improve on my assessment practices and I will receive a compensation of twenty-five thousand francs (approximately $60) upon completion of the study. All materials used in the research lessons will remain in my school.

All the information collected from me will be confidential. My name will not appear on any other papers or tapes on which information is collected or recorded. The lesson plans reflection reports, transcribed interviews and all other information will be coded, and the researcher will keep a separate master list with the names of the participants and corresponding code numbers. These data will be stored in a locked drawer in the researcher's office. Once the data are analyzed, the master list will be destroyed. Pseudonyms will be used for reporting purposes.

I may refuse to answer a question or participate, and I may quit at any time during the study without prejudice or penalty. If I have any questions or concerns about this study, I may contact Herb Fynewever at (269) 387 5393 or George Akom at (269) 387 7611. I may also contact the Chair of
Human Subjects Institutional Review Board at 269-387-8293 or the Vice President for research at 269-387-8298 with any concerns that you have.

This consent document has been approved for use for one year by the Human Subjects Institutional Review Board as indicated by the stamped date and signature of the board chair in the upper right corner. Do not participate in this study if the stamped date is more than one year old.

My signature below indicates that I have read and/or had explained to me the purpose and requirements of the study and that I agree to participate.

_________________________________________  ______________________
Signature                                      Date

Consent obtained by: _________________________  ______________________

Researcher's initials                          Date
Appendix C

Consent Form 2
Enhancing Science Teachers' Assessment for Learning Skills through Lesson Study

Western Michigan University, Mallinson Institute of Science Education
Principal Investigator: Herb Fynewever, PhD
Student Investigator: George Akom

I am invited to participate in a research project entitled, "Enhancing Science Teachers' Assessment for Learning Skills through Lesson Study". This research is intended to examine and improve science teachers' assessment for learning views and practices through lesson study. The study is George Akom's doctoral dissertation and may be published or presented at professional meetings.

I will be asked to complete a two-page questionnaire of about 30 minutes duration concerning my assessment practices. The study will permit me to reflect on my assessment practices.

As in all research, there may be unforeseen risks to the participant. If an accidental injury occurs, appropriate emergency will be taken. However no compensation or treatment will be made available to me. I am, however, not aware of any physical or economic risks that might result from my participation in this study. In the case of any discomforts, inconveniences, or apprehensions on my part, I will tell the researcher. All the information collected from me will be confidential. My name will not appear on the questionnaire and I will return the questionnaire in a sealed envelope. The hard data will be destroyed once the information is sent to the researcher. The data will be stored in a locked drawer in the researcher's office. The information will be reported as group data.

I may refuse to answer a question or participate, and I may quit at any time during the study without prejudice or penalty. If I have any questions or concerns about this study, I may contact Herb Fynewever at (269) 387 3393 or George Akom at (269) 387 7611. I may also contact the Chair of Human Subjects Institutional Review Board at 269-387-8293 or the Vice President for research at 269-387-8298 with any concerns that you have.

This consent document has been approved for use for one year by the Human Subjects Institutional Review Board as indicated by the stamped date and signature of the board chair in the upper right corner. Do not participate in this study if the stamped date is more than one year old.

My signature below indicates that I have read and/or had explained to me the purpose and requirements of the study and that I agree to participate.

______________________________
Signature

______________________________
Date

Consent obtained by: ___________________________
Appendix D

Assessment Questionnaire
Provide responses to the following questions concerning assessment in your classroom. Please, be as detailed as possible in your responses. Thank you!

Age:

Subject you teach

Years of teaching:

1. How do you usually assess students in your classroom?
   • When and how frequent do you carry out these assessments?

2. What information do you gather from student assessments?
   • What do you do with the information collected? (Of what use is this information?)

3. What type of activities do you normally engage the students in?
   • Do you involve students in pair or small-group activities in preparation for whole class discussions? How often and why?

4. What type of feedback, (if any), do you give to students?
   • How prompt is the feedback?

5. What role do students play, (if any), in the assessment process?
   • If students play any role in the assessment process, how important is this to you?
Appendix E

Classroom Vignettes
**Vignette A: Decomposition**

A fifth-grade teacher embarking on a unit about decomposition wanted to help his students realize that some plant material is cycled through decomposition and incorporated into other plant material.

Before beginning, however, he decided to find out what his students knew and thought about the processes involved. To find out, he arranged the students in groups, gave them some leaves, and asked them to discuss what they knew about how leaves changed throughout a year. What would these leaves have looked like in the spring? What will they look like in the fall? What will they look like by next spring?

Then he asked each group to produce a series of drawings showing how their leaves looked now, what they might have looked like before, and what they would look like in the fall and next spring. The students were asked to annotate their drawings with explanations of the changes they depicted.

**Vignette B: Fertilizer I**

In a fifth-grade class, students were involved in investigating the effect of various fertilizers on the growth of different kinds of seedlings. Some students planted lettuce seedlings, some nasturtium, some cabbage, and others used various kinds of tomato seedlings.

One group set up their trials very carefully, using the same soil before mixing in equal amounts of fertilizer, filling identical pots, and planting seedlings of the same size in them. However, the teacher noticed that they watered their seedlings without taking care to use the same amount of water for each one.

As they clearly were aware that they needed to keep things the same for fair comparisons, the teacher asked them if they thought it mattered that they'd watered their plants with different amounts of water. They said it wouldn't make any difference because any extra water would just go to the bottom of the pots and drain away.

The teacher realized that this had implications for their understanding of how fertilizers work, as the students did not seem to realize that the fertilizers could be washed away.

She asked them to investigate separately what happens when small amounts of fertilizers are put in water. They observed that the fertilizers dissolved and realized that the amount of water was a variable that had to be controlled for a fair test. They also advanced their ideas about how plants could be affected by fertilizer.
Vignette C: Fertilizer II
At the end of their investigations of fertilizers, the teacher held a discussion with the whole class about how to report their work so that others could understand what had been done, what had been found, and how it could be explained.

The students ended up with a list of points that made a good report of an investigation. The teacher wrote these in large print on a chart and pinned it to the wall. While the students wrote their reports of their investigation, they were reminded to pay attention to the points listed. When they presented their reports to each other, they used the list to make constructive comments about how the reports (their own and others) could be improved.

Vignette D: Camouflage
At the end of a unit on camouflage in animals, a teacher asked her fourth-grade students to write down answers to the following questions to see how they were able to apply the ideas she hoped they had grasped.

1. Brown bears are found in the mountains in Canada and white bears in the Arctic. Why do you think you don’t find white bears in the mountains and brown bears in the Arctic? Think of as many reasons as you can.

2. Many kinds of “big cats” such as tigers and leopards have stripes and blotches on their coats.
   a. Write down as many ways you can think of that this helps these animals.
   b. Write down as many ways you can think of that this might not help these animals.

3. Some fish have darker colors on their backs than on their undersides. Can you think of a reason for this?
Appendix F

Classroom Vignettes Activity Sheet
Read Vignettes A–D. Answer these questions for each:

1. Does what is described include assessment?
2. If so, what information was gathered?
3. If so, by whom was it gathered?
4. About whom was it gathered?
5. Who used the information and how?

<table>
<thead>
<tr>
<th></th>
<th>A Decomposition Vignette</th>
<th>B Fertilizer I Vignette</th>
<th>C Fertilizer II Vignette</th>
<th>D Camouflage Vignette</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Is there assessment?</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>2. What information was gathered?</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>3. By whom?</td>
<td></td>
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<tr>
<td>4. About whom?</td>
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<tr>
<td>5. Who used it and how?</td>
<td></td>
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</tbody>
</table>
Appendix G

Hinged Mirrors and Floating Eggs Activity Instruction Sheet
1. Do the activity at your table.

**Hinged Mirrors Activity**
- Observe how the images of the penny change when the mirrors are at different angles.

**Floating Eggs Activity**
- Switch the eggs between the tap water and the salt water and see what happens.

2. After you've done the activity, individually and without discussion, write on a card ONE QUESTION you might ask if you wanted to find out what ideas students had to explain what was going on. (Don’t put your name on the card).

3. Take 10 minutes to do the first activity. When you’re done writing your question, a facilitator will collect the card and bring a different set of materials to your table.

4. Take 10 minutes to do the second activity. This time, when you’re done writing your question, take a few more minutes to share it with others at your table, discussing the similarities and differences in terms of what each question asks of the student.
Appendix H

Student Work Samples: Sound
Sample 1

I think I hear the sound by listening hard and I think it could be because the drums sound is very loud.

Sample 2

When you beat the drum it vibrates and the sound rolls across the drum. The sound comes through the holes and they are pointed up so.
Appendix I

Comparing Generic and Specific Indicators of Ideas
Generic indicators of development can be "translated" into specific indicators, as shown here.

<table>
<thead>
<tr>
<th>Generic Indicators</th>
<th>Specific Indicators</th>
</tr>
</thead>
</table>
| *When giving an explanation or making a prediction, do the students:*
| 1. Do no more than describe the situation, rather than explaining it? | Simply describe what happened when the drum was hit? |
| 2. Use their own preconceived ideas, rather than scientific ones? | Use preconceived ideas about sound, rather than scientific ideas? |
| 3. Refer to relevant ideas without showing how they apply? | Mention the relevant ideas: that sound is caused by vibration; that we hear sound when it travels to our ears? |
| 4. Apply the relevant ideas only in situations similar to those already encountered? | Apply ideas about sound correctly in this situation? |
| 5. Apply the relevant ideas in situations different from those encountered before? | Use these ideas in explaining sounds made by other objects and suggest that sound travels through the air to the ear? |
| 6. Bring several relevant ideas together to give a reasoned explanation or prediction? | Make a connection between vibration of objects that are sources of sound and vibrations in the air reaching the ear to create the sensation of sound? |
Appendix J

Student Work Sample: Crayfish
Crayfish Adaptation

Fourth-graders finishing the Structures of Life FOSS Kit set up a habitat for a crayfish. They cared for their crayfish and observed it for several weeks. On this occasion, students were asked to draw a crayfish, correctly label all its body parts, and explain the function of each of those parts. The teacher’s goal, relating to the big ideas about adaptation, focused on understanding that each part of the crayfish served a particular purpose; that each structure had a particular function.

The student wrote:

*Habitat and Other Information about the Craw Dad: They are crustaceans like lobsters, shrimp, and crabs. They like to live on rocks. They need shade to live. You can put any amount of water in the home. They can swim on its side. It's body is covered in a shell. They can hardly see out of their eyes. Their antennae helps them find their way. They go back in the holes when they are scared. They eat pellets. They can swim backwards. When they are mad they open they claws.*
Appendix K

Assessing Ideas Activity Sheet
Look closely at the student work and follow the instructions below. Be sure to keep your written notes as you work. You’ll need them again in the next part of the workshop.

1. Working with your partner, describe what you see in the student work on Crayfish Adaptation so you’re both clear about what is there before beginning to interpret it.

2. Using the list below, “translate” the generic indicators into specific indicators, keeping in mind the ideas the teacher wanted the student to develop. (Note: Don’t spend too much time doing this. You may be able to complete the next part of this activity by using the generic indicators alone.)

3. Use the list of specific indicators you just created to interpret the student’s work and find the current level of the student’s ideas. (You can work from the generic indicators if you prefer.)

4. Use the indicators to identify the student’s next step in development. Then note any specifications the teacher could take to help the student take that next step.

These generic indicators are expressed in very general terms, but they can be “translated” to apply to any scientific concept.

Generic Indicators for the Development of Students’ Ideas

When given an explanation or making a prediction, do the students:

1. Do no more than describe the situation, rather than explaining it?

2. Use their own preconceived ideas, rather than the relevant scientific ones?

3. Refer to relevant ideas without showing how they apply?

4. Apply the relevant ideas only in situations similar to those already encountered?

5. Apply the relevant ideas in situations different from those encountered before?

6. Bring several relevant ideas together to give a reasoned explanation or prediction?
Appendix L

Effective Feedback Activity Sheet
Using your notes from the last part of the workshop, along with the student work samples on Sound and Crayfish Adaptation, consider how the teacher could best provide written feedback to the student in each case.

**If you were the teacher, what would you put on the page?**

Below, please write the exact words you would use, and explain the reason for your choice.

**Crayfish Sample**
Appendix M

Some Do's and Don’ts of Evaluating Student Work
Do:

1. Plan tasks with specific learning goals in mind.
2. Identify one or two aspects for comment and review, which are related to the planned learning goals.
3. Comment first (and perhaps only) on aspects specific to science, since the task was set to help learning in science.
4. Think carefully about whether or not any other comment is needed at all, for instance about neatness or effort, deserving though these may be. By all means acknowledge and encourage effort and progress, but not in away that diverts attention from how to improve and move ahead.
5. Pinpoint weak aspects, such as misuse of a technical term, but don’t be pedantic about the use of words or about assertions the student may have made that are not supported by their own evidence.
6. Give students time to read, reflect on and, where appropriate, respond to comments.
7. Indicate next steps.

Don’t:

1. Give judgmental comments, and above all scores or symbols (such as B+ or 7/10) since these divert children’s attention from learning.
2. Don’t pose rhetorical questions (“Do you think so?”, “I wonder why?”), but by all means pose questions, so long as the student understands that a response will be expected and will be read.
3. Don’t waste precious time on evaluating tasks that are mainly about reinforcement. Concentrate on work that is really worth evaluating for its science.
Appendix N

Follow-up Study Questionnaire
Name:

Critically reflect on your lesson and provide thoughtful responses to the following questions. Please, be as detailed as possible.

1. How well did you follow the formative assessment cycle? Use specific instances from the lesson to substantiate this.

2. What methods did you use in gathering information about student learning? (Think about questioning, group work, etc.). How did you use this information in the learning process?

3. What type of feedback did you give the students? Was the feedback oral, written, judgmental or non-judgmental, comments only, marks only, or comments plus marks, etc?

4. How were the students involved in the assessment process? Did they assess their work or their peers’ work? How exactly was this done?