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RESHAPING TEACHER THINKING, PLANNING AND PRACTICE USING EMBEDDED ASSESSMENT: CASE STUDIES OF THREE MIDDLE SCHOOL SCIENCE TEACHERS

By

Letina Ngwenya Jeranyama

A DISSERTATION

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ABSTRACT

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At the dawn of the 21st century the science education community is seeking ways of improving science education to produce a scientific literate citizenry. They have put forth new goals. Teachers are key to all efforts to improve schools, that without their full participation, any move to reform education nor matter how well intentioned is doomed to failure. The changes in the goals of science education imply that teachers have to change the way they teach science. Some scholars have suggested that one way to help teachers attain the reform goals is by using embedded assessment.

Embedded assessment is defined as a cyclical and ongoing process whereby teachers gather data about students' understanding as they teach, they analyze the data formally or informally and use the analysis to plan or adjust teaching immediately, for the next hour, day, topic, unit or year. The next day's activities also include embedded assessment and so the cycle repeats itself. This study investigates how teachers make sense of embedded assessment, how embedded assessment looks in practice, how it influences teachers and their classroom environments and the challenges teachers face as they use embedded assessment.

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Three middle school science teachers were involved in the study. Data were collected through semi-structured interviews with open-ended questions, participant observations and professional development conversations. Data were analyzed using the qualitative method of constant comparative analysis.

The findings indicate that teachers passed through different stages in conceptualizing embedded assessment. This conceptualization influenced the way embedded assessment looked in the classroom. Embedded assessment took many forms and shapes in the teachers' classrooms. Embedded assessment influenced the teachers' perspectives about the curriculum, students, teaching, assessment, planning and reflection in ways that enabled the teachers to be ***investigators*** of their students' understanding, ***designers*** of what to do to advance that understanding and ***evaluators*** of teaching strategies. Even though teachers thought that it was hard to teach using embedded assessment because it presented pragmatic challenges, it improved the teachers' repertoire of teaching and assessment practices. It gave teachers concrete evidence about their students' understanding of scientific concepts.

The dissertation also develops a model or framework in which contemporary goals of science education, embedded assessment and 'new' theories of learning are interconnected and intertwined. This model shows that the three parts complement each other but the problem is that they are being used in an old system that makes change hard.

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ACKNOWLEDGEMENTS

The past few years in graduate school have been a journey that is filled with fears, doubts and joy. I never could have started and finished the intellectually demanding and emotionally challenging journey alone. There are several people who have contributed to my growth into the teacher, researcher and a person I am today. Although some of them may not read this dissertation, I still want to thank those who have transformed my life.

First, I would like to extend my appreciation and gratitude to my academic advisor and dissertation director, Dr. James Gallagher. Jim has been more than an advisor to me. I describe him as a 'father I never had'. He provided me with financial support through the assistantships and encouragement that enabled me to grow as a scholar.
In addition to Jim, I want to express my gratitude to the committee members, Dr. Deborah Smith, Dr. Douglas Campbell and Dr. John Metzler. In different forms they have been very helpful in writing this dissertation. Thank you all for your consistent support, encouragement, written feedback and conversations about my work.

I also want to express my wholehearted thanks to the three teachers, Marian Jones, Lisa Leslie and Sarah Williams for their excellent cooperation and openness to being observed and interviewed. Thank you for staying after school for the professional development meetings and sometimes interviews. This dissertation would not have been possible without the participation of any of them.

Now that I am preparing the final report of this dissertation, the images of several friends and colleagues comes to mind. All of them have a special place in my heart. Carolyn O'Mahony and Gaston Dembele helped me make sense of my data and improve my writing. They interrogated me with hard questions that enabled me to dig deeper into

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issues. I would also, want to thank Shinho Jang for his technical support and encouragement.

I thank my mother who did not give up on me and had so much reverence for education. The emphasis she placed on education made me pay serious attention to learning. I am deeply indebted to her for sending me to school and paying for my high school education.

I would also want to thank my sister and sister in law Sue Galuza and Anna Jeranyama for taking care of my kids and managing the household chores during my writing. You have planted a seed and in due season you will reap. Thanks ladies. I am so proud of my two sons Bongani and Kunashe who have been such an inspiration to finish my work quickly and be a mother to them. I deeply appreciate and admire the patience, cooperation, maturity and understanding these two little boys have exhibited.

Saving the best for the last, I would like to thank my husband Peter Jeranyama, who has shared with me good and difficult times. We have grown together during our years at Michigan State University. Peter is such a resourceful person who shares so many wonderful ideas. His belief in helping people achieve their maximum potential is one big reason that allowed me to pursue this journey. It is a great blessing to have Peter, as a life partner, and many of my accomplishments would not have been possible without his support and understanding. I am greatly indebted to him for being such a wonderful father to our sons and providing them with best care and comfort. Thank you, Peter, for putting up with my irritating ways. The end is here!

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In reflecting on my journey and the numerous feelings it has brought to my heart, I want to thank my savior and Lord Jesus Christ who has given me the strength to do all things through him. I continue to walk in his plan for my life.

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CHAPTER ONE

INTRODUCTION

At the dawn of the 21st century, the science education community is seeking ways of improving science education. As a result four books were released to outline the vision of science education for K-12. The first step in outlining the current reform in science education was the publication of Science for all Americans (AAAS, 1989) by project 2061. Two years later, the Michigan Department of education distributed the Michigan Essential Goals and Objectives for Science Education (K-12). In 1993, Project 2061 published a detailed description of the goals of science education Benchmarks for Scientific Literacy (AAAS, 1993). In 1996, the National Research Council published the National Science Education Standards (NRC, 1996). These books present reform goals and standards for the reform in science education and challenge how science is taught and assessed in the classroom.

I believe that teachers are at the center of all efforts to improve schools, and that without their full participation and leadership, any move to reform education, no matter how well intentioned or ambitious is doomed to failure. Sarason (1982) and Fullan (1991) pointed out that teachers were key to any educational change. Furthermore, Gusky & Huberman (1995) argued "we cannot improve schools without improving the skills and abilities of the teachers within them. In other words, we should see change as an individual process and be willing to invest in the intellectual capital of those individuals who staff our schools" (as cited in Gusky & Huberman, 1995, p118). The changes in the

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goals of science education imply that teachers have to change the way they teach science. However, little attention has been given to teachers to help them with how to teach to attain these reform goals. Teachers are left puzzled with how to change their teaching.

Some scholars (Gallagher & Parker 1997; Anderson & Speck 1998; Wiggins 1998) argued that embedded assessment was among the tools that had the potential for helping teachers achieve reform goals. This argument was based on anecdotal evidence that supported the efficacy of embedded assessment in improving teaching and learning. This is problematic because there is only very few studies that have looked at how embedded assessment is used in the classroom, e.g., Treagust & Jacobwitz (1997). Bell (2000) and Wiggins (1998) studied what they called formative assessment. They defined formative assessment as assessment that is intended to enhance teaching and learning. This type of assessment is similar to embedded assessment. The difference between Bell (2000) and this study is that Bell's work focused on the process of formative assessment in science classrooms. My work focused on the process, plus the influences and challenges that the three science teachers faced as they learned and used embedded assessment in their classrooms. Internationally, scholars have done some work on formative assessment. But we need further understanding about how embedded assessment is used in the classroom and how it influences teachers' thoughts and actions. Further, there is limited information about how teachers actually use embedded assessment in their classrooms and even less systematic information about the pitfalls and problems teachers face in implementing this approach with their students. Research is needed to learn more about the use of embedded assessment in the classroom. To this

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end, this dissertation seeks to investigate the utilization of embedded assessment by three middle school science teachers and how it influenced their thinking, practice and the classroom environment. I will start by defining what I mean by embedded assessment then discuss the current science reform, and then situate embedded assessment in that reform.

What is embedded assessment?

Embedded assessment is assessment that is merged with teaching. Unlike traditional assessment (Bybee, 1997) which often takes the form of a test or quiz administered after teaching, embedded assessment involves the use of teaching activities that reveal students' thinking and reasoning while they are learning. Therefore, with embedded assessment the line between teaching and assessment is blurred (Duschl & Gitomer 1997). Embedded assessment is a cyclical, ongoing process whereby teachers gather data about students' understanding as they teach, analyze the data formally or informally, and use the analysis to plan or adjust teaching as they teach or next hour and or next year (Gallagher & Parker, 1997; Wiggins, 1998; Duschl & Gitomer 1997; Champagne et al, 1990; Anderson & Speck 1998; Wiske, 1998; Bell 2000; Stiggins 2001). The next day's teaching also includes embedded assessment and so the cycle repeats itself.

This idea is supported by Dewey's (1938), principle of continuity of experience: every experience takes up something from those which have gone before and modifies in some way the quality of those which come after. Dewey's idea is relevant in embedded

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Conceptual model or framework for embedded assessment

In this section, I discuss my conceptual model of embedded assessment and the teaching framework which has evolved based on my experiences working with teachers and professors (Gallagher, Parker, Wilcox & Lanier, NSF (National Science Foundation; professional development school and Eisenhower professional development projects). I will give a detailed example about one teacher's use of embedded assessment. This will clarify to the reader the meaning and components of embedded assessment.

From the definition of embedded assessment, it can be seen that the conceptual model of embedded assessment has three elements that describe the teachers' actions:

1. **Gathering** information about students' understanding as students work on tasks that expose students' ideas and reasoning as they learn. Information can be derived from oral, written or graphic products obtained from watching students at work, from listening to students during informal conversations or in response to probing questions.

2. Engaging in deep **analysis** of this body of information to inquire about what students seem to understand, and what they seem to be struggling with, yields clues from various sources of information. It also produces evidence about what students know and how they know it.

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into account the learners, the learning goals and possible courses of action for making progress toward these goals (Gallagher & Parker, 1997; Wiggins, 1998; Kulm & Malcolm et al, 1991; Anderson & Speck, 1998; Champagne & Lovitts 1991; Duschl & Gitomer 1997; Wiske 1998; BSCS, 1989). (See figure 1.)

The three elements of the conceptual model indicate that teaching activities also become assessment activities. These activities are designed to achieve several goals. First, they are designed to be engaging to students with different interests and experiences. This is an important feature of ongoing assessment as described by National Science Education Standards (NRC, 1996). Second, the variety is meant to model the multiple opportunities to make sense of new idea-key idea and this is important in aiding understanding. Strategies like group work and peer analysis help develop communities of learners, which are components of effective teaching. AAAS (1989) argued "learning often takes place best when students have opportunities to express ideas and get feedback from peers (p.187)". An example of the teaching/assessment activity is shown below:

Students are supposed to pretend to be blood and apply for a job in a human body. The task is to write a job description that explains their qualifications for that job and the application should reflect the importance of the job (Human Body Systems, p.16).

Wiggins (1998) suggested that in order for any activity to be adapted as an assessment activity, teachers needed to ask themselves several questions, for example: Is there sufficient clarity about the link to the key idea? Will all my students find this activity worthwhile and if not what should I do to prepare them for the task?

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Assessment Criteria

As the students carry out the activity in the above example, the teacher should have assessment criteria. These are questions that are designed to guide teachers in interpreting students' responses. The teacher should focus on students' understanding and application of science content (Wiggins 1998; Wiske 1998). These criteria might be regarded as rubrics, or guidelines, that the teacher uses to determine students' understanding of the key idea. However, the focus is not on grading. An example from the Human Body Systems (Gallagher & Parker 1997) booklet which could be used with the above assessment activity is:

- "How well do students describe the role or job of the blood? Do they just say blood keeps people alive? Or do they go further and explain what blood's essential roles are?
- Do the students include the four main components of blood, i.e., plasma, red blood cells, white blood cells and platelets?
- How accurate and complete are students' descriptions of the structure and function of each component of the blood? Do they include the following points:

Plasma is the medium in which cells and platelets are suspended. It also carries dissolved nutrients, waste products, salts, ions and proteins. Red blood cells are the carrier of oxygen by hemoglobin and white blood cells are the means of fighting bacterial infections by ingesting and destroying bacteria" (Gallagher & Parker (1997), p. 17)

Student work

The work of one student will be used to illustrate how one teacher analyzed student work to design or adjust instruction.

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[1] A sixth grade student who was in one school district where we piloted the embedded assessment project wrote this. Note that this whole project was planned for middle school. The discussion therefore is

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Analysis of student response

The teacher analyzed the work of all her students to see if their explanations were complete and if not plan strategies to address this problem. For this student, the teacher used the assessment criteria (human body systems p.15) to evaluate the students' work. The teacher's analysis stated:

"The student followed the expectations of this assignment and has given facts about different components of blood. A confusing point was that the student introduced herself as a blood cell instead of whole blood containing the components mentioned. Given the style of writing, it is possible this student was drawing directly from class notes. My worry about this student is that this student has a set of facts about blood in mind, but not a picture of the systematic character of the blood system. Student does not have a complete understanding of blood functioning as a system." (Human Body Systems, p.17).

In general, the teacher said this about the difficulties that most students in her class had with this activity, "Students could not visualize that blood is made up of distinct parts, and carries food and oxygen to the cells and wastes away from the cells" (Human Body Systems p.17). It should be noted that analyzing student work is a challenging activity for most teachers because it requires different skills than just grading, such as looking deeply to search for meaning and misconceptions. Teachers require skills of how

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to assess for understanding. Wiggins (1998) reported that the Quebec assessment (which embraces similar ideas as embedded assessment project) raised havoc with conventional security and ease of using traditional assessment. The teacher in this example, whose student's work was discussed above, had worked with National Science Foundation project for two years and she used the project booklets to help her with ideas about analyzing student work.

The teacher's plan: Instructional adjustment

The teacher felt that the students were beginning to pull ideas together but needed further clarification. She felt that students were interested enough that she could extend the lesson. Therefore, she made a follow up 'phone call' role-play to the students. She told them she was extremely interested in hiring them but needed to know for sure if they were qualified to handle the job of carrying goods from place to place in the body. The students were instructed to make a list of things that they could carry and describe where they would pick them up and deliver them. She made individual "calls" to students who had written confusing information in their original assignment (Human Body Systems, p.17).

The components of embedded assessment from this example were:

- gathering information from the student
- analyzing the information
- giving feedback
- adjusting instruction

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The following session will give an overview of contemporary science education goals and then embedded assessment will be situated in the context of the current reform to show that embedded assessment is an important teaching and assessment strategy that fits well in the current reform. I will also give a brief historical background of why I am choosing to study embedded assessment. The section above has given the conceptual model about embedded assessment and a practical example of how one teacher designed a lesson for embedded assessment. The next section will look at the contemporary goals of science education and embedded assessment.

Overview of goals of science education from the contemporary reform perspective

Goals of scientific literacy from the contemporary reform perspective fall under the following headings 1) science for all; 2) broader spectrum of science content; 3) less is better; and 4) teaching for understanding.

Science for all

Project 2061 and National Science Education Standards have promoted the slogan "Science for all" to highlight awareness that science should be part of the education of every student. This is a change in the main science education goal to produce scientists that was promoted in the 1960s then science was for the privileged few, the academically talented that could compete for scientific superiority over the Soviet Union. The reformers of the 1990s realize that the world has changed in such a way that scientific literacy has become necessary for everyone, not just a privileged few. Human beings now face problems that are global (AAAS, 1989) and science related issues

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Therefore, what the future holds in store for human beings depends on the wisdom with which *all* humans use science and technology. Science for *all* implies the same standards and learning outcomes for every student without exception (Bybee 1997; AAAS, 1989).

The *National Science Education Standards* (NRC, 1996) list the following goals for school science:

After thirteen years of school science, a scientifically literate citizenry should be able to:

- experience the richness and excitement of knowing about and understanding the natural world
- use appropriate scientific processes and principles in making personal decisions
- engage intelligently in public discourse and debate about matters of scientific and technological concern
- Increase their economic productivity through the use of knowledge, understanding and skills of the scientific literate person (NRC, 1996, p.13). These goals define a scientifically literate society.

Project 2061 has similar general goals that address the knowledge, skills and attitudes

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essential for scientific literacy that all students should acquire as a consequence of their education from kindergarten through high school. According to *Science for All Americans (1989),* a scientifically literate person is one who:

- has integrated knowledge of different disciplines of science, mathematics and technology;
- has a deep conceptual understanding of scientific concepts and ideas; and
- appreciates that both the knowledge and the practice of science are dynamic and constructed (AAAS, 1989, p. x).

The reformers are realizing that skills needed to function in an information-technological society are changing in the 21st century. New skills such as abilities to learn, reason and think creatively, make decisions and solve problems are needed by *all* students in order to work and live safely in the changing world (AAAS, 1989). The field of science education is undergoing changes and is pursuing new goals so as to bring about reforms in science that respond to current and emerging needs.

Broader spectrum of science content

Project 2061 and National Science Education Standards set out a broader scope of science literacy. By incorporating inquiry, integrating themes and historical perspectives about the development of scientific ideas and technology, the reform leaders have broadened the content base of science to lessen its abstract nature, connect science with the world of students and make it understandable and practical. By doing this the reformers are hoping to make science interesting and worth learning for all students.

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- emphasize the integrated understanding of unifying concepts or common themes in science, for example, systems, models and patterns of change;
- focus on familiar concepts from physical, life and earth sciences;
- call for the addition of technology and the history of science;
- include developing scientific habits of mind;
- encourage the application of science to personal and social contexts;
- focus on understanding the nature of science, mathematics and technology; and
- focus on an enquiry based science program (NRC, 1996; AAAS 1989).

All of these points are part of the subject matter that has been broadened to achieve the reform goal of scientific literacy. It is broadened in the sense that it is including topics that were not part of science content for example, the historical perspective. Even though it has broadened in scope, it still emphasizes the " less is better" adage in terms of scientific content.

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"Less is better"[2]

Project 2061 and National Science Education Standards proposed new pedagogy that was designed to foster understanding. The reform agenda encourage teachers to slow down and cover few topics each year. This was also supported by Third International Maths and Science Studies (TIMMS, 1997) that found out that teachers in the USA covered more content compared to other countries and therefore encouraged teachers to cover less that they did presently. The idea of "less is better" is based on the recognition that understanding and application require more time than the accumulation of facts (AAAS, 1989; Roth, Anderson & Smith 1994). The intention is to promote understanding by reducing the number of technical terms students are responsible for learning and changing the way science is taught. Rowe (1985) has shown that new terms may be introduced at the rate of one every four minutes of class time over the entire year in high school biology and chemistry classes. The blueprint for the education of project 2061 science teachers (NCRTL, 1994) argued that reducing the number of terms does not mean that science is watered down in some way. Rather, the primary goal is to change what it means to teach, learn and understand science and this is in line with embedded

[2] Not everyone in science education chants the mantra that less is more or better. Marv Drugger, former NSTA president, for example believes that less is less and more is more. He believes that by cutting down on the number of topics taught, we are doing students a disservice. They can specialize after graduating from high school. Obviously there is a limit to the notion of less is better. It would be possible to teach science-taking Duckwoth (1996) to the extreme- spending a year on the phases of the moon, for example. As far as I know no one is advocating for such extreme measures.

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assessment conceptual model or teaching framework.

Teaching for understanding

Project 2061 and National Education Science Standards have raised a significant challenge for K-12 science education, that is, scientific literacy for *all* students. The reform agendas have elaborated the vision of science literacy and have made understanding and application of science key elements of scientific literacy. They have placed the scientific literacy goal of understanding at the center of the current reform. *Science for all Americans* (AAAS, 1989, p.185) recommended, "schools should concentrate on the quality of understanding rather than on the quantity of information." What is understanding and why is this goal elusive as an instructional goal? Understanding is the ability to think and act flexibly with what one knows (Perkins, 1998). Understanding also includes the mental models that students have (White & Gunstone, 1992; Wiggins, 1998). Furthermore, Champagne, Klopfer & Anderson (1980), Driver & Erickson (1983), Strike & Posner (1982) suggested that, although students might have learned factual content and terminology in order to pass tests, their own preconceptions interfered with an understanding of scientific explanation of phenomena. Brophy & Good (1986) argued that even teaching that is good often fails to bring about change in students' preconceptions. A number of science educators have been working at investigating the kinds of teaching that are effective in facilitating students' conceptual change that may lead to understanding. These scholars include (Anderson & Smith 1983a; Driver 1987; Nussbaum and Novak 1982; Posner, Strike, Hewson & Gertzog

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1982; Strauss & Stavy 1983) who advocates for putting the teacher's focus on students' ideas and their predictions and explanation of phenomena.

Perrone (1991) argued that teaching for understanding is not a new goal because it has long been endorsed as a primary educational goal. This goal has been difficult to achieve and to foster among students because of what teachers do in their classrooms. Too many teachers focus on rules and learning of facts contained in the textbooks (Anderson & Smith 1983a; D. Smith & D. Neale 1991). This kind of teaching treats learning as a passive process (AAAS, 1990). Students are treated as if they are "empty vessels" that do not possess prior knowledge about a topic. Students end up memorizing the knowledge dispensed by the text or teacher. This kind of learning does not lead to understanding.

Embedded assessment is one way to help teachers focus on understanding because it requires teachers to recognize the incomplete conceptions that students bring to science classrooms, and to adjust their instruction so as to take into account what students bring, thereby helping teachers in their efforts towards achieving scientific literacy.

The work on embedded assessment fits into the reform agenda in that it is directed towards the achievement of all four of the premises of the reform goals discussed above. Of much interest to this dissertation is teaching for understanding and making science accessible to a wide spectrum of student population. The choice of two out of the four goals as central to this dissertation does not diminish the importance of the other goals. The choice is based on a desire to give a focus. By helping teachers gain information about students' ideas and reasoning pertaining to science concepts, and then using that

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information to guide instructional decisions, a deeper understanding of science and an increase in students' ability to apply it in their life is fostered. In doing this, the portion of students who understand science is increased. One side effect is to assist teachers with the knowledge and skills needed to slow down the rate at which science is taught, so that deeper understanding and application of science becomes a reality. This is consonant with the principle 'less is better'.

Changes in teaching

Clearly, with these new goals of scientific literacy, there should be a change of what it means to teach, learn and understand science. *Project 2061 and National Science Education Standards* called for a new vision of teaching and learning, which emphasized that teachers must:

- become effective in teaching science to *all* students
- teach for understanding and application, which entails focusing on students' thinking and ideas, making them dissatisfied with their own explanations, and leading them to search for better ones. (Posner, Strike, Hewson & Gertzog 1982; White R. & Gunstone R. 1992)
- develop a rich repertoire of teaching skills that engage students in effective learning for understanding and application of science
- learn to use continuous assessment as a tool for guiding students' developing understanding
- develop skills of reflective teaching so that they can capitalize on the

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Of interest to this study is 'assessment conducted by classroom teachers', teaching standard (C) in the National Science Education Standards, which states that:

- Teachers of science should engage in ongoing assessment of their teaching and student learning. In doing this teachers,

Use multiple methods and systematically gather data to guide teaching. They also use student data, observation of teaching and interactions with colleagues to reflect and improve teaching practice (NRC, 1996 pp.37-38).

As noted above, reformers have broadened the use of assessment in the classroom because when most people think of assessment they think of grading and testing that are prevalent in most schools. Wiggins (1998) argued that a different kind of student assessment was needed than the one used in most schools. Wiggins argued that tests do not serve students because they are inherently incapable of giving students the feedback that is central to learning and they do not help teachers to improve their performance. Because tests come after teaching and learning are over and therefore serve a summative function rather than a formative function.

There are many different forms of assessment, for example, pre and post assessment, authentic assessment, etc., but of interest to this study is embedded assessment. The next section will discuss why traditional tests are an insufficient method of assessing and the philosophical beliefs about embedded assessment that show that it is a promising idea that can help teachers with the new vision of teaching.

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Why is traditional testing an insufficient method of assessing?

I argue that we should not totally ignore the use of traditional assessment, but broaden the use of embedded assessment at the classroom level so that it can benefit the learner and the teacher. The prevalent forms of assessment are not sufficient and the next section offers a brief account of why they are insufficient method of assessing.

The use of tests and quizzes has encouraged or at least helped perpetuate classroom practices that fail to provide high quality education. These tests have failed to adequately measure important learning. Multiple-choice tests treat learning as memorizing isolated pieces of information, rules and procedures. This approach assumes that one first accumulates the bits and only thinks later. To the contrary, psychologists now understand that humans from infancy learn by actively attempting to make sense and meaning of the world. At all ages, people construct knowledge and meaning in their minds (Phillips, 1995; Brooks & Brooks, 1993).

Use of tests for accountability has given them a powerful influence over teaching. For example, in Zimbabwe where I come from and in other countries as well, because the teachers are held responsible for their students' test scores, they often teach to the test. Instruction ends up focusing on the narrow content of the test and overemphasizing memorization at the expense of thinking or understanding. Furthermore, students spend a great deal of time reviewing information that is assessed on the tests and teachers spend a great deal of time teaching to the test (Marino, Pickering & McTighe, 1993). There is a need to broaden the use of assessment in the classroom because of the potential to

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influence what goes on in the classroom. The following section will give a brief account of the philosophical assumptions underlying embedded assessment.

Philosophical beliefs and theoretical assumptions of embedded assessment

1. Embedded assessment treats learning as an active process

Learning is not something that is given to some one else. Rather, students actively search for new meanings to transform their present understanding (Greene, 1988). The focus in classrooms that use embedded assessment is on the student (in terms of who talks and whose ideas are important) and not the teacher. This is a shift from what happens in classroom where the teacher is the giver of information and students listen passively or read the textbook (Roth 1986; Anderson & Smith, 1987; Anderson & Speck, 1998; Greene, 1988). In the traditional approach, assessment usually comes at the end and serves a summative function. In embedded assessment, assessment occurs throughout and serves a formative function to guide teachers and students through the process of teaching and learning.

2. Embedded assessment emphasizes both process and product rather that product only

In using embedded assessment, concepts that are not completely understood are revisited using different strategies. Deep analysis of students' ideas as they learn is done so as to adjust instruction accordingly. This ensures that students have more than one chance to learn a concept or principle. The ongoing analysis of students' work gives the teacher information on what students understand and what they do not understand. The

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teacher can design teaching strategies that will help them grasp the concepts at a time when it can be acted on and before confusion and inappropriate conceptions deepen and solidify (Wiggins, 1998; Gallagher & Parker, 1997, Duschl, 1997). The teacher does not have to wonder at the end of the unit why students are performing poorly. The purpose of assessment is to facilitate learning and not just to document learning. Because of all these theoretical assumptions, embedded assessment shows promise for improving classroom practice. However, these assumptions are based on beliefs and not research and therefore, there is need to conduct research on the use of embedded assessment. In the following section, I discuss my reasons for choosing to study embedded assessment. The research questions will be situated in this context.

What scholarly work supports the idea of embedded assessment?

Grant Wiggins in his (1998) book, Educative Assessment, argued that teachers must learn to think like assessors all the time and to ask, "what is the evidence of learning?" and "how will I teach toward it?" instead of implicitly asking "what will I cover and have students do?" He argued that all students, especially the least and most able, are capable of better performance than they now accomplish. This is not because students and teachers are flawed or lazy but because schools are mostly ineffective performance systems. He further argues that as long as assessment is viewed as what we do after teaching and learning are over we will fail to improve students' performance. He suggested different purposes of assessment, which are:

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- educative assessment implies that assessment is no longer separate from instruction; it is a major essential and integrated part of teaching and learning.

He argued that we have wrongly construed assessment as a problem of tinkering with test techniques. Wiggins (1998) reported that excessive reliance on short tests has landed in a world described as "teach, test and hope for the best". Wiggins argued that the gap between our teaching effect is profound we can close it by learning to think like assessors of our own teaching and students' skills and understanding. Clearly, these ideas are similar to embedded assessment.

Black & William (1998) reviewed research in the 1990s to seek evidence on whether the development of formative assessment raises standards of learning. They found about ten studies, which showed significant learning advantage for their formative assessment experiments, with effect sizes ranging from 0.4 to 0.7 remarkably large for any educational experiment. Several studies showed that low achievers or slow learners showed the largest gain. They also concluded that the learning advantage of enhanced formative assessment is a robust effect, not dependent on particular details of implementation. They also found out that the research confirmed that classroom assessment practices were weak.

These are the common features they found among the ten studies:

- traditional assessment encouraged rote learning and superficial learning;
- teachers were not critical about what was being assessed; and
- the grading function was over emphasized and the learning function was

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Black & William (1998) concluded that

1. Teachers have to bear the dual roles of being guides and assessors;
2. Teachers' formative assessment was very weak and ought to be developed;
3. That it was necessary to have research, which looks at the problems of formulating and implementing formative assessment.

In this study, I address several of these issues in the context of middle school science classrooms.

Another scholar who has done work in this area is Beverley Bell in New Zealand. She defined formative assessment as assessment that is intended to enhance teaching and learning. Bell (2000) reported findings of a three-year study into the process of formative assessment in science classrooms with 10 teachers. The findings from her study indicated that teachers used two kinds of formative assessment i.e. planned and interactive. Planned formative assessment involved the teachers eliciting and interpreting assessment information and then taking action. She said that this tended to be carried out with the whole class. Interactive formative assessment involved the teachers noticing, recognizing and responding and tended to be carried out with individual students and small groups. These types of assessment are integral to the teaching and learning process and are dependent on a teacher's pedagogical knowledge. Bell also reported that there is little research on the process of formative assessment. This study builds on Bell's work by examining the process of formative assessment in middle school science classrooms.

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Historical background and framing the research questions

Assessment has had a profound influence in my life as a student and as a teacher. As a student, in Zimbabwe, assessment (grades) determined how far I proceeded with my education. Right from the first day I stepped in the classroom, I was assessed on whether I knew how to count, or read simple words. The purpose of the assessment was to track students based on the assessment results. Students who could not read, count and recognize the alphabetical letters were placed in different classes. They were often placed with 'incompetent teachers'. This meant that they were disadvantaged from the beginning of their school life. The educational system in Zimbabwe was tracked at that time. As I moved on in the educational system, it was clear that students were not only tracked, but also encountered the bottleneck system. This meant that if you did not pass a certain grade level, you did not move on to the next grade level. As a result most students did not move beyond 8^{th} grade.

My high school science experience was a nightmare, because of the cramming of the biology terminology, which I (and many others) did not understand. We spent huge amounts of time memorizing isolated pieces of information. We would sit and the teacher would lecture and give notes. In Zimbabwe, teachers would panic if there were a topic they did not cover. Assessment was used for accountability, so students would complain, "we did not cover this topic". The use of tests encouraged or at least helped perpetuate the kinds of learning and classroom practices that failed to provide high quality education because the tests did not measure important learning. As a teacher, the students' test scores measured my effectiveness. The instruction ended up focusing on the narrow

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content of the test and emphasizing memorization at the expense of thinking or understanding. As a student and a teacher, it bothered me how much power the traditional tests had on the learning and teaching. I was held responsible for the National Examination test score results of my students. Since assessment drove what happened in the classroom, I wondered if it could be used so that teachers could focus on understanding rather than memorizing. So, when I came to graduate school, I was fortunate enough to find professors that were interested in alternative uses of assessment in the classroom. Gallagher and Parker (1992) started developing this idea of embedded assessment. During the past years, I have worked as a Graduate Assistant for the National Science Foundation assessment project directed by Drs. James Gallagher & Sandra Wilcox. My involvement in the assessment project has shown me that embedded assessment has a potential to change classroom practice. I have developed resource materials and facilitated staff development programs, to assist middle school science teachers using embedded assessment. As a result of my experiences in the assessment project, I noticed that there was a lot going on for the teachers as they tried to implement the idea of embedded assessment in their classrooms. I began to wonder about issues that were brought forth in staff development sessions (for example, how embedded assessment looks like in the classroom) and these issues contributed to the framing of my research questions.

The assumptions about embedded assessment discussed earlier on are based on philosophical assumptions and not empirical research and therefore the purpose of this study is to aid in filling this gap by analyzing its impact on teachers. Fullan (1991) argues

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that we cannot improve schools without improving the skills and abilities of teachers within them. Having looked at the research on assessment so far, there are questions that still need to be answered. There are few studies that have focused specifically on how teachers make sense of embedded assessment; and most studies do not examine what embedded assessment looks like in the classroom. My study extends earlier work by focusing on these research questions:

1. How do middle school science teachers make sense of the idea of embedded assessment?
2. How does embedded assessment look in practice in middle school science classrooms?
3. What impact does embedded assessment have on teachers and their classroom environments?
4. What are the problems/ challenges/ tensions that teachers face as they learn about and do embedded assessments in their classrooms?

Significance of the study

I believe that the information gathered from this study could inform theory about the effectiveness of embedded assessment as a teaching and assessment strategy. It is my hope that this study will:

1. Inform teachers about the use of embedded assessment in classrooms in terms of benefits, strengths and challenges of this approach.

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2. Inform reformers about assessment standard that are conducted by classroom teachers and whether embedded assessment helps teachers attain the reform goals of scientific literacy and teaching for understanding.

3. Help the policy community recognize the importance of a long neglected issue, teachers and their learning needs, so that professional development could be improved.

4. Help educators understand the complexities involved in learning a new idea and implementing reform ideas at the classroom level, thereby reminding the education community to pay attention to teachers and what they do, to provide necessary support for ongoing professional development.

5. Provide insights into the claims about embedded assessment by providing empirical evidence to support or refute them.

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CHAPTER TWO

REVIEW OF RELATED LITERATURE

In chapter one, I have given a review of the literature about assessment and science education reform, but in order for this to be complete, a literature review about teacher learning, professional development, educational change and reforms in education is necessary. This study is at the intersection of all these research literatures. This kind of thinking about assessment poses challenges for most teachers to change their conventional practices of knowledge telling and didactic methods of teaching to more demanding forms of teaching. Teachers need to learn about how to use embedded assessment so literature on teacher learning is necessary. This literature review further elaborates the main points in my argument.

What do science teachers need to teach using the idea of embedded assessment?

In order to teach using embedded assessment, science teachers need to think in new ways about subject matter, the curriculum, general pedagogical practices, students, and the contexts in which they are teaching. Most importantly, they need to acquire pedagogical content knowledge (Borko & Putnam, 1990; Grossman, 1990; Shulman, 1987) for example, how to adjust instruction to suit the way students are responding. All of these changes entail teachers changing their existing beliefs about the teaching and learning process. For example, it also means a view of student learning that is no longer information gathering, but an active process of knowledge generation. For many teachers, learning to teach in new ways may require a renewed mindset or at least a mental shift that incorporates change in four areas:

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1) In-depth subject matter knowledge

This includes substantive knowledge of the content (key ideas, concepts, organizing principles) as well as the syntactical structure of the discipline, which may lead a teacher to look into the explanations, interpretation, discussions and deeper analysis involved in the teaching of the subject (Schwab, 1978; Shulman, 1987). A growing body of case studies reveals how the presence or absence of this kind of knowledge affects the learning opportunities that teachers provide for their students (Ball & McDiarmid, 1990; Grossman, 1990; Wilson & Wineburg, 1988). The portraits of teachers struggling to make their knowledge explicit to their students make a compelling case why teachers need deeper and more flexible subject matter knowledge than they generally have a chance to learn (Feiman-Nemser & Remillard, 1996).

The subject matter knowledge of most teachers is likely to be limited to what they have learned during their student days. The subject matter preparation of teachers may be narrow with respect to the topics they are required to teach. Just as we now expect students to be able to use the knowledge to explain the real world phenomena, teachers must be able to do that as well, and their subject matter preparation may not have adequately prepared them for that task. Many teachers may not have had opportunities to formulate questions from real world phenomena, develop investigations to answer their questions.

The key point related to this study is that to use embedded assessment effectively teachers must have strong subject matter knowledge. This enables teachers to teach to the understanding of key ideas and to help students with their naïve conceptions. Whereas there is evidence that subject matter knowledge is not sufficient to insure effective

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teaching of subject matter (Magnusson, Krajcik, & Borko, 1999), some critical amount of subject matter knowledge seems to be necessary in using embedded assessment.

2) Pedagogical content knowledge (PCK)

Even when teachers have a thorough grounding in their subject matter and they understand their learners, more is needed to promote effective learning experiences by students. Grossman, Wilson and Shulman (1989) have argued that while subject matter knowledge is the foundation for teaching, it is not enough alone to make teaching meaningful; the key to teaching is the act of transforming disciplinary knowledge into a form of knowledge that is appropriate for students and specific to the task of teaching.

The knowledge, which helps teachers connect subject matter to their students in meaningful ways, has been labeled pedagogical content knowledge or PCK (Shulman, 1986). It is a special amalgam of content and pedagogy, which includes ways of representing and formulating the subject that make it comprehensible to others. Shulman (1986) describes this PCK as a second kind of content knowlwdge,

.....which goes beyond knowledge of the subject matter per se to the dimension of subject matter for teaching. Within this category of PCK, I include the most regularly taught topics in one's subject area, the most useful forms of representations of these ideas, the most powerful analogies, illustrations, examples, explanations and demonstrations, in a word, ways of representing and formulating the subject that make it comprehensible to others. PCK also includes an understanding of what makes the learning of specific topics easy or difficult; the conceptions and preconceptions that students of different ages and backgrounds bring with them to the learning of those most frequently taught topics and lessons (Shulman, 1986, pp. 9-10).

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In other words, this knowledge transformation process involves, a) preparation through critical interpretation and analysis of the content, b) representation of the ideas in the form of new analogies, metaphors, demonstrations and so forth, c) selection of the appropriate methods and models of delivery, and d) adaptation of instructional materials and strategies to suit student characteristics and context. It refers to the capacity of a teacher to transform the content knowledge into pedagogically powerful lessons that are adaptive to the variations in ability and background presented by students (Shulman, 1987) so they adjust their learning accordingly. It is the ability to adapt different forms of representations in multiple ways in order to meet specific goals of specific learners. In Dewey's terms, it means to "pyschologize" the subject matter, to rethink disciplinary contents and concepts in order to bring it within the range and scope of students' lives and make it meaningful (Dewey, 1964). One also should consider it the ability to rethink instructional strategies in order to incorporate students' thinking and ideas.

3) Knowledge of learners and their contexts

Dewey (1938) said, "All genuine education comes through experience. Experience is educative only to the degree that this knowledge modifies the learner's outlook, attitude and skill.....failure of adaptation of material to the needs and capacities of individuals may cause an experience to be non-educative"(pp 36-39). This explains very well what embedded assessment advocates, that is the importance of taking students' ideas, prior beliefs and understanding into account while planning and teaching. This is not an easy task and may pose great challenges to teachers because it is asking teachers to teach in ways that are fundamentally different from how they were taught. This way of using embedded assessment and teaching in this manner differs from the

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teachers' existing orientations of teaching science and beliefs about science teaching, assessment and learning. Students also vary in terms of their academic capabilities and intellectual abilities. Their abilities vary according to the amount of cultural capital (Bourdieu, 1978) and social capital (Lareau, 1989) they are endowed with by their family heritage, parents and surroundings.

Magnusson et al (1999) pointed out that teachers needed to be knowledgeable about areas of student difficulty in science. This includes topic areas in which the student prior knowledge is contrary to the targeted scientific concepts. This is knowledge about misconceptions and misconceptions are a common feature of science learning (Driver, 1994). Scientific concepts for which students have misconceptions can be difficult to learn because misconceptions are typically favored over scientific knowledge because they are sensible and coherent and have utility for the student everyday life. In contrast, the targeted scientific concepts may seem incoherent and useless to the learner. Teachers need to be aware of these misconceptions because it helps them interpret students' actions and ideas. This is particularly important in using embedded assessment because teachers continually analyze and gather information about student reasoning and difficulties so they can address those difficulties. Magnusson et al (1999) argued that although teachers have some knowledge about student difficulties, they commonly lack important knowledge necessary to help students overcome those difficulties. Therefore, in this study it was important to provide professional development opportunities that helped teachers respond effectively to student misconceptions, i.e., probing for student reasoning rather than correcting misconceptions and supplying more detailed explanations that may not alter students' thinking.

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4) Teachers' belief about students, subject matter, teaching and learning

Ball (1996) defined beliefs as what we think we know. She argued that beliefs are more than opinion, but they are less than the ideal truth. For most teachers, conceptions of teaching and learning tend to be eclectic collections of beliefs and views developed over time (Feiman-Nemser, 1983; Cohen & Ball, 1990). Moreover, some teachers still believe and operate under the assumption that teaching is telling, knowledge is facts and learning is recall (Cohen, 1988). Teachers who operate under the assumption that students are empty vessels waiting to be filled, believe that students are passive recipients who act as depositories of knowledge (Freire, 1970) and that the teacher's responsibility is to dispense information that students absorb and somehow use later (Darling-Hammond, 1997). With such understanding, many teachers take the central role in the classroom and monopolize the whole teaching and learning process.

In these cases, not much opportunity is given for student participation. But with embedded assessment, full participation from the student is required. Therefore, when using embedded assessment most teachers would have to change their conceptions about teaching (Cohen, 1991; Tatto, 1999). To do this, Cohen (1991) argued that teachers needed to revolutionize their teaching practices instead of cobbling new ideas onto familiar practices.

Other research studies for example, reviews by Richardson (1990) and Borko and Putnam (1996) highlighted the central role played by teachers' beliefs and conceptions when learning new ways to teach. If beliefs do not change, then teachers' learning about new teaching strategies may not be deep enough to support genuine change in instruction or it may result in misinterpretation of strategies and materials.

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The key points for this study is that the teachers' knowledge and beliefs serve as filters through which they come to understand embedded assessment. These understandings, in turn, determine how components of embedded assessment are utilized in practice. Just as students' existing knowledge and beliefs serve as the starting point for their learning, teachers' knowledge and beliefs are important resources and constraints on change (Magnusson, et al 1999). The professional development in this study was structured in a way to expose and challenge pre-existing beliefs (Borko & Putnam, 1996).

What do we know about learners and learning?

Loucks-Horsley, Hewson, Love & Stiles (1998) have put forth a summary of what is known about learners and learning. They give five general concepts that frame what is known currently about learning.

1) Learners possess a diverse set of alternative conceptions about natural phenomena that influence their future learning.
2) Learners acquire new knowledge by constructing it for themselves.
3) The construction of knowledge is a process of change that includes addition, creation, modification, refinement, restructuring and rejection.
4) The new knowledge learners' construct for themselves has its origins in a diverse set of experiences.
5) All students, regardless of race, culture and gender are capable of understanding and doing science (p. 27).

Other scholars (Cobb, 1994; Driver, Squires, Rushworth & Wood-Robinson, 1994) argued that the conventional view is that knowledge is received from others when learners listen to what they say. They believe that learning is more complex than that.

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They argue that learning is a process that learners need to do for themselves rather than one that is done to them by others. This does not imply that others are not influential in the process, but recognizes the active role that learners need to play to learn. When learners try to understand new information, they use their existing knowledge and their own ways of learning. The process of learning involves the construction of links between new ideas and what learners already know to create meaning.

Another important aspect of learning is the process of personal reflection. Good learners are able to monitor their own ideas and through processes, compare and contrast them to that of others and provide reasons why they accept one over the other.

Current research also supports the idea that learning is mediated by the social environment in which learners interact with peers and others. Beach (1993) argued that individual learners interpret what they read, see, hear and feel but at the same time, learners influence the sense making each makes of their common experiences.

These concepts about learning challenge the current perspective at work in many schools today. For example, that people acquire concepts by receiving and memorizing information from other people who know more than they do, that students will learn what their teachers know by listening to what they say, and that the presence of other students is incidental to learning (Schifter, 1996). This changed view of learning is relevant in this study for two reasons: first, I will be studying teachers, and their views about how children learn will be made visible as I observe their classrooms. Second, it gives us a lens that enables us to structure professional development that will maximize both teacher and student learning. These ideas and theories about how people learn drove the way the

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professional development for this project was designed. The next section will discuss the research on professional development.

Teacher professional development

For teachers to learn to use embedded assessment in their classrooms, there is a need to provide effective professional development. The most prevalent forms of professional development will not help teachers make a transition in their teaching. (Ngwenya, 1998) provided a portrayal of what was happening in the assessment project professional development. The model of professional development that was prevalent in most sessions in the study by Ngwenya (1998) was short term and not sustained. This contrasts with contemporary ideas of effective professional development, which are long term, ongoing professional development programs (Gusky & Huberman, 1995; Hargreaves & Fullan, 1996; Liebermann, 1995; Little, 1994).

Darling-Hammond and McLaughlin (1995) noted that effective professional development engages teachers both as learners and as teachers, and allows them to struggle with the uncertainties that accompany each role. Little (1998) identified the following features of effective professional development:

i) Ensures collaboration adequate to produce shared understanding and shared investment;

ii) Requires thoughtful development and the fair rigorous test of selected ideas via collective participation in training and implementation;

iii) Focuses on crucial problems of curriculum and instruction;

iv) Occurs often enough and long enough to ensure progressive gains in knowledge, skill and confidence;

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Abdal Haqq (1995) identified the following similar characteristics of effective professional development:

1) is on going (meaning participants meet on a consistent basis and not just one time throughout the project);
2) includes training, practice, and coaching or other follow up procedures;
3) is school based and embedded in teacher work;
4) is collaborative, providing opportunities for teachers to interact with peers;
5) focuses on student learning which should, in part, guide assessment and its effectiveness;
6) encourages and supports school based and teacher initiatives;
7) is rooted in the knowledge base for teaching;
8) incorporates constructivist approaches to teacher learning;
9) recognizes teachers as professionals and adult learners; and
10) provides adequate time and follow up support.

Putnam and Borko (1997), Elmore (1997), and Lieberman (1994) provide similar lists of the features of effective professional development.

How does the literature on teachers' learning and professional development influence the design of my study?

The literature reviewed so far has highlighted the importance and complexity of teachers' learning in order to change instructional practices. Since teacher learning is so

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complex, it cannot be achieved through brief in-service training and short, intermittent courses. Thus in my study, ongoing learning and reflection about embedded assessment occurred throughout the study. Teachers were provided with support as they begun to use embedded assessment in their classrooms so as to avoid what Lortie (1975) called the "sink or swim" model. Teachers and the researcher determined the objectives of the instructional unit jointly. The review of literature on teacher learning influenced the researcher to pay particular attention to teachers' content knowledge, teachers' PCK, teachers' knowledge of students and their contexts, and the teachers' belief systems, particularly during the professional development sessions. Learning to teach in new ways requires a renewed mind set in these four arenas. Research about effective professional development guided the professional development part of this project. Thus the review of literature on teachers' learning and what is needed for effective professional development formed the lens that guided this study.

What is known about teachers and teaching?

Three general concepts frame what is currently known about teachers and teaching.

1) The purpose of teaching is to facilitate learning.
2) Teachers are professionals with specialized knowledge.
3) The practice of teaching is complex (Loucks-Horsley, 1998 p. 30).

Loucks-Horsley et al (1998) argued that sometimes teaching does not cause learning to occur. Regardless of how good a teacher is and how appropriate the tasks of teaching are to both the learner and the content to be learned. If the learner does not intend to learn there will be no learning.

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Schon (1988) has argued that professional practice is complex and uncertain and it uses an expert knowledge base. The perspective of teachers as professionals is in contrast to a view of teachers as skilled technicians and of teaching as the expert application of bodies of disciplinary knowledge. On the contrary, teachers have a large body of knowledge that is worthy of respect. Coble & Koballa (1996) and NRC (1996) argued that teachers have a body of knowledge that includes knowledge of the content of the discipline, of the students they teach, of the forms of assessment strategies they use and of the larger context in which they teach. Equally important is pedagogical content knowledge (Shulman 1986).

As professionals, teachers realize that learning about teaching does not stop when they are credentialed. Rather, they expect to continue learning throughout their teaching career and to improve their practice with appropriate professional development opportunities. The relevance of this to my study is that, I entered with these lenses about teachers and teaching.

How does the literature on teacher learning influence the design of my study?

The literature reminds us of the complexities of teaching. Teachers' work is not easy work but is professional work requiring professional judgement of situations and decision-makings. There are multiple factors that affect teachers and how they teach and make sense of ideas, and therefore this led me to ask questions about teachers and how they enact and make sense of embedded assessment.

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What does the literature say about educational change and reform?

Fullan (1991) and Loucks–Horsley (1998) argued that educational change is both an individual and an organizational phenomenon affecting each and every educator as well as the schools, districts and universities. They put forth the following principles that derive from the knowledge base on change:

- Change is a process that takes time and persistence.
- As individuals progress through a change process, their needs for support and assistance change.
- Change efforts are effective when the change to be made is clearly defined, support and assistance are available, and leaders and policies support change.
- Most systems resist change.
- Change is complex because it requires people to communicate with one another about complex topics in organizations that are, for the most part, large and structured.

Liebermann (1999) argued that educational change of value require individuals to act in new ways (demonstrated by new skill, behaviors, activities, etc.) and to think in new ways (beliefs, understandings and ideas). She pointed out that the question of the relationship between thought and actions is important for professional development. She further argued that conventional wisdom has been that changing teacher beliefs should be the primary work of professional development, because when one believes differently, new behaviors will follow. She stated that research on teacher change, however, indicates that changes in attitudes often result when teachers use a new practice and see their students benefiting (Guskey, 1986). She argued that instead of being linear, changes in ideas and attitudes, actions and behaviors occur in a mutually interactive process. On the

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other hand, people's current thoughts influence what choices they make and what they attend to as they plan and carry out educational activities, so changes in attitudes and behaviors is interactive in well-conceived professional learning. This literature on teacher change influenced my thinking about changing teachers' assessment practices, in that I expected it to be a long process with many factors influencing change. The research on educational change helped me to pay close attention to teachers' beliefs, attitudes and behaviors. The literatures discussed above and in chapter one form the lens that guided this study.

To summarize, the review of related literature supports the main argument of this study. Literature on teacher learning and educational reforms supports the notion that for the successful use of a new idea (embedded assessment), teacher learning is vital. Teachers need to have thorough grounding in the subject matter knowledge, knowledge of learners and their contexts, and pedagogical content knowledge. In order to teach in new ways, such as using embedded assessment, teachers need to recast their conventional beliefs about students and the subject matter, and re-conceptualize their ideas about teaching and learning. For many teachers, these needs entail unlearning and relearning and thus effective professional development was a necessity in this study.

My study originated as a graduate assistant in the National Science Foundation assessment project and was enhanced by literature related to science education reforms, formative assessment, professional development and educational change. So, my enquiry started with experiences and literature, which led me to ask questions, collect and analyze data, which led me to seek out more literature and more insights. This process is discussed in more detail in the next chapter on methodology.

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CHAPTER THREE

METHODS OF DATA COLLECTION AND ANALYSIS

In this chapter, I discuss how I conducted the study, including the research approach, data collection methods, data management and analysis.

Research approach

This study used qualitative case study methods of research to study, analyze and compare three teachers' work. I selected a qualitative study because the nature of my research questions required that participants give meaning with respect to embedded assessment. Teachers were studied in their natural setting, classrooms, so that the findings would not be out of context. Denzin and Lincoln (1994) argued that qualitative, naturalistic and interpretive studies help people understand the enormously complex problems of schools, since other forms of research methods often fail to probe deeply into the intricacy of a problem. Qualitative research methods were appropriate because they allowed me to peer deeply into the heart of issues surrounding teachers' utilization of embedded assessment.

Quantitative surveys, which claim to represent many teachers, typically extract composite accounts of key issues but do not offer rich and comprehensive understanding of the "perspectives" that teachers bring to their work. In-depth portraits of a small number of teachers would, however, provide fuller access to their views across a range of issues (Gronn & Robbins, 1996). Therefore, in my study, I decided that the use of a qualitative case study design was the best method to understand and explain, in an in-

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The particular qualitative approach used is the case study. Until the 1970's, the use of the case study was seldom considered to be a proper educational research method. Currently, it has become one of the most popular and usually respected form of studying educators and educational problems. Stake (1997) noted that even though case studies have not found the solution for education's problems, researchers and others have appreciated their deep, self-referential probes of problems. Case study method was chosen because the cases are the three teachers who are learning to use embedded assessment, and it is bounded by time (12 weeks of data collection). This study is an exploration of how teachers use embedded assessment over time through detailed, in-depth, data collection involving multiple sources of information rich in context, which makes it appropriate to use the case study method.

Instead of studying one teacher, I decided to study three teachers so that I could offer a cross-case analysis, which enabled me to make some limited generalizations about how embedded assessment impacts teachers' practice. Three teachers were studied rather than one because an interpretation based on evidence from several cases can be more compelling than results based on a single case. Creswell (1998) recommended that when multiple cases are chosen, a typical format is to provide a detailed description of each case and themes within the case, followed by a thematic analysis across the cases. Therefore, in my study, each teacher was treated as a comprehensive case. Data were gathered to describe each teacher's use of embedded assessment. Then, data from all

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three teachers were cross-analyzed to build a general explanation that fits each of the individual cases, even though the cases might vary in detail (Yin, 1984).

Research context

Selecting research sites

This study was conducted in two middle schools in low to middle income, urban neighborhoods. These schools were selected because the teachers who volunteered to participate were staff members at these two schools. Two of the teachers taught at the same school. The schools were in one school district. Initially, I had three teachers from three different schools. A week after the study started, one of the teachers dropped out due to illness. Lisa (a teacher in this study) then referred me to Sarah Williams, who was at the same school. Marian's school was located in a very low-income neighborhood while Lisa and Sarah's school had a mixture of students from very low to average, income neighborhoods. Lisa's school was using a teaming concept, which was very strong in Sarah William's case. Lisa was in a team but teachers in her team did not follow what was mandated by the administration.

Why did I choose teachers from this school district? I assumed that change was needed especially in low-income neighborhood schools. I had worked in the district earlier for professional development schools and I was familiar with the issues with which teachers at these schools faced. I thought that learning about embedded assessment would improve the heart of what matters most, i.e., the instruction.

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Recruitment of teachers

In August 1999, the school district and the Michigan State University Professional Development School project offered a workshop to all middle school science teachers in the Lansing district. I attended this workshop as a graduate assistant for the project. I advertised my study at this workshop. From a pool of those teachers, six volunteered to participate in the study (see figure 3.1). I then purposefully selected three teachers who were in the same grade level because I thought it would be both easier and more informative to study teachers in the same grade level who are teaching the same subject matter content. In the pool of teachers who volunteered, 2 were 8th grade teachers and one was a sixth grade teacher. I therefore, selected 7th grade teachers because three teachers working at the same grade level would permit a better cross case analysis. Also if one teacher dropped out of the study, I would still have two teachers for the cross-case analysis. Therefore, in no way were the three seventh grade teachers more special or significant than the other teachers who were not invited to participate in the study.

Research design

Table 3.1 and Table 3.2 summarizes the research design of this study. This section describes in detail these two figures. I started this project by observing teachers prior to learning embedded assessment and this explains the term pre-embedded assessment phase in the diagram. I also interviewed the teachers after the classroom observations for a week to see how their practice was before learning about embedded assessment. The classroom observations and the first interview shaped the first professional development session in that teachers were asked to reflect on what they were doing in the classrooms. Phase 1, occurred after the first professional development. I observed all three teachers

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three times with the same class and then I interviewed the teachers. After the interview, I observed three lessons per teacher. This was followed by a professional development meeting in Marian's classroom. This sequence of events was the same for phase 2, 3, and 4.

Professional development

The three teachers selected for my study attended four sessions of professional development in the use of embedded assessment (see table 3.1 and table 3.2). These meetings occurred in the teachers' classrooms. They took place after school and the site rotated among the two schools represented. This was strategic, firstly, because the meetings occurred after school, so the teachers did not need to drive to a location for two of the meetings. Secondly, I thought that teachers would feel at ease, comfortable, and close to the realities of both teaching and schools. The meetings were scheduled for two hours. The professional development started with two meetings where the teachers were introduced to the underlying concepts of embedded assessment, e.g., use of key ideas, gathering information, adjusting instructional strategies, analysis of students' work, etc. We also examined the ecosystem booklet on assessment and the assessment strategies booklet.

These booklets were the result of four years of collaboration among middle school science teachers, university scientists, and university science educators. The materials represent the results of a process in which the group worked together to help create improved teaching skills. The booklets were written to help other middle school science teachers develop their skills in using embedded assessment.

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The booklets are based on research on students' learning and understanding of science, advice from teachers, guidance from scientists and recent reform documents I talked about in chapter one. The booklets contained key ideas, a list of difficulties students often encounter when learning science based on the literature, e.g., (Driver 1994), and teachers' practical knowledge about students and learning science. They also contained a set of teaching assessment activities that advance and assess students' learning of the content encompassed by each key idea. They also included the assessment criteria (an example was given in chapter one) for each activity and examples of students' work for selected activities, along with teacher's interpretation of their work and suggestions for next steps for teachers. These materials were not intended to be a curriculum. They were supplemental resources to be used with any of several curricula or texts in middle school science.

The assessment strategies booklet contains different strategies. It explains what each strategy is and gives a practical example that was tried and tested in the classroom. The following are the strategies in the booklet:

- Journal Writing, Mind stretcher & student generated questions
- Models, pictures, diagrams
- Concept mapping, Peer Analysis & Proposition generation
- You become the teacher, role playing & inquiry projects
- Graphing, laboratory demonstrations & experiments

Since all three teachers were teaching the ecosystem unit, we used the ecology booklet produced by Michigan State University, on a National Science Foundation project. This booklet incorporated the principles of embedded assessment. We told teachers that they

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could use this booklet to examine how you can design instructional strategies as teaching and assessment strategies, to see how to use key ideas, to see examples of how some teachers analyzed student work, and planned to adjust their instruction. Teachers were asked to bring students' work so that they could share with others what they did and how they analyzed student work for their follow up session of professional development. The second professional development meeting focused on what teachers needed for support of what they were trying to do in the classroom. They were asking questions and reporting issues that were challenging for them. The following table (3.1) summarizes the professional development sessions in terms of strategy used, reasons and the purposes. Dr Gallagher (professor at Michigan State University) and I planned the first meeting but the other meetings were co-constructed by teachers and the 2 project staff.

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Table 3.1 A summary of the professional development sessions

Date	Purpose	What was done	Why?
Feb 2000	Developing awareness/building a knowledge base	Pre-assessment of what teachers knew or thought about E.A. Introduction of E.A. & booklets. Discussion of teaching / assessment strategies. Teachers given an assignment to try EA in their classrooms	To uncover what the teachers thought about EA and encourage a general discussion of this approach.
March 2000	Reflection on using EA in the classroom	Teachers worked together to discuss how they explored EA in their classrooms. What worked? What did not work? Group brainstormed ideas for improvement	To provide time for teachers to support each other and puzzle through problems and challenges.
April 2000	Examination and analysis of student work and planning an EA lesson together.	Teachers looked at in-depth analysis of student work in the assessment booklet and examined their own student work	To improve teachers' analytical skills and planning of lessons that use EA.
May 2000	Open discussion about embedded assessment. Prepared questions to ask the group.	Teachers discussed the practice of EA, how they have improved in their use of EA. Teachers critiqued each others' work and provided suggestions for improvement	To look for evidence of teachers' learning. To provide feedback, support and a platform to exchange ideas.

Data collection Procedures

Data collection began in early March 2000. The time line is given in the table that follows:

Table 3.2 Tim

Time line
January Febru 2000
Feb 28 - March
March 6
March 7-13
March 20-22
March 27
March 27- 31
April 1-9
April 10-14
April 18
April 19-21
April 22- Ma
June 15

Table 3.2 Timeline for 12 weeks of data collection

Time line	Activities
January /February 2000	Writing of UCRIS (University Committee on Research Involving Human Subjects) and requested permission to do research in the school district. Called the teachers, made arrangements for conducting the study, and asked what topics they would be teaching. This was important for planning professional development meetings.
Feb 28 - March 3	*Pre-assessment Period* Observed each teacher 3 times with one class of their choice or any class that fit my schedule and conducted Interview # 1. Types of data collected: field notes, audiotapes.
March 6	*Professional development period* Professional development sessions #1: focused on the principles of embedded assessment and facilitated by Dr Gallagher; I was a participant observer in these sessions. These were 2-hour meetings conducted after school.
March 7-13	Interview # 2 for teacher a, b and c.
March 20-22	Observed teacher a, b and c. Conducted interview # 3 for all teachers.
March 27	Follow up professional development session # 2.
March 27- 31	Observed teacher a and conducted Interview #4
April 1-9	Spring break
April 10-14	Observed teacher b & c conducted interview # 4
April 18	Follow up professional development session # 3
April 19-21	Observed teacher a & conducted interview # 5
April 22- May 31	Observed teachers b & c conducted interview # 5. Professional development session # 4.
June 15	Final exit interview # 6 for all three teachers

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As table 3.2 indicates, I had 12 weeks of data collection, a short but adequate period of time for a study involving qualitative methods. During some weeks of the study, I divided my time equally between two teachers so that I was conducting my study simultaneously for these two teachers and on a rotating schedule among the three teachers.

Types of data collected

The data for this qualitative study were collected through extensive interviews, casual conversations, classroom observations and participant observations, and field notes. I had asked teachers to audiotape the lessons that I did not observe but this did not materialize. Teachers reported that they kept on forgetting, and others said it was disruptive for students who wanted explanations for recording. Yin (1989) recommended multiple forms of data collection for case studies so as to give an in-depth picture of the case. The details of the various kinds of data collected are given below.

1.**Interviews**

A total of 18 semi-structured interviews (six per teacher) with open-ended questions were conducted and audiotaped. Informal conversations were written down in my notebook during and after the conversations. The interviews were organized around the major research questions. These major research questions were further broken down into a number of sub questions, which guided my thinking throughout the interview process. The teachers' responses also shaped the outcome of the interviews in that the questions that were asked were probed and built upon the responses given by the

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teachers. I also audiotaped all four professional development meetings. The major research questions and sub questions provided a broad guideline to structure the interview (see appendix for questions asked during the interviews).

2. Observation and Participant observations

In addition to conducting interviews, I observed teachers in the classrooms and during the professional development sessions. The observational notes included both descriptive and reflective notes, i.e., notes about what was going on, hunches, and learnings, as recommended by Cresswell (1998). Issues that I paid particular attention to include:

- Do teachers display an in-depth knowledge of subject matter, for example, do they focus on key ideas and concepts?
- Do teachers look deeply into students' explanations/ answers/ written work and responses in class?
- Do they gather any information to use in the next lesson?
- Do they have any skills to interpret-analyze students' work?
- What are the strategies teachers use? Are they used for both teaching and assessment?
- Do teachers require students to be explicit and detailed in describing their ideas?
- Do teachers consider students' ideas, prior beliefs, and misconceptions while planning and during instruction?

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- Are teachers aware of common student difficulties for this topic? If so, how do they use this knowledge?
- What do teachers consider as they plan instructional moves?
- Do teachers revisit concepts that are not completely understood?
- How do teachers structure their questions? Do they require elaborate answers?

3. Casual conversations

After classroom observations, I had casual conversations with the teachers. We talked about various issues, for example, what happened during the lesson, the teacher's reflection about the lesson she had and other matters that the teacher felt I needed to know. Sometimes, the teachers asked me questions about how they could improve on their use of embedded assessment. I gave suggestions and not prescriptions. I wrote notes and reflections about these conversations soon after we talked. The teachers were very relaxed during these talks and seemed to be getting more comfortable with discussing issues with me. These conversations helped me to understand the contexts of my study and life in classrooms.

4. Field-notes

Field-notes were essential to figuring out what teaching using embedded assessment looks like in middle school science classrooms. Each time I observed a teacher, I took detailed field-notes using a notebook that was designated for each teacher. I noted as much of what I heard and saw, and who was saying or doing it. I also wrote analytical notes. These notes and questions took on many different forms and purposes. Such notes consisted of questions that I might ask for the next interview or conversation

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that were based on classroom occurrences. They were also directed to me because they gave an interpretation to what I was seeing or a connection between a particular observation on this day with something else that happened earlier. I also looked at my notes on a weekly basis and wrote reflections about what I thought was happening.

Data Analysis

I transcribed and indexed all the interviews. Indexing was done by creating codes for each participant, noting the interview #, page in the manuscript, and date the interview was conducted. Codes were assigned for each transcript and each segment in the transcript so as to allow me retrieve data and cross reference information while writing and reporting. All the field notes were typed and coded. After organizing the data, I read the transcripts in their entirety several times so that I immersed myself in details and got a sense of the interview as a whole before breaking it into parts. Memos were written in the margins of field notes or transcripts, and attention was paid to emerging themes and patterns. I then wove these memos and thoughts to see if I could come up with a bigger picture, which spoke to themes and patterns. Stake (1995) advocated for direct interpretation of data analysis in a case study research, which fits well with my study because it looks at a single instance and draws meaning, from it without looking for multiple instances. Each teacher was treated as a case and cross-case analysis was done. I displayed data in the form of charts with themes, e.g., teachers' perspective on students before and after embedded assessment.

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I found that categorizing my data according to some bigger themes was helpful. This helped me come up with assertions, which helped me make sense of the data. The major assertions I came up with are:

- Teachers' making sense of embedded assessment occurred in stages that were different for each teacher.
- Embedded assessment took many shapes and forms in the teacher's classrooms, and these varied from teacher to teacher.
- Embedded assessment influenced the teacher, students, and the classroom environment in ways that the teachers viewed as beneficial for them and their students.
- All the teachers faced problems, tensions, dilemmas, and struggles as they used embedded assessment in the classroom.

The evolution of themes

Since I used the 'constant comparative method' of analysis (Glaser & Strauus, 1967) which involves the combination of data collection with analysis, my preliminary analysis of data started as soon as my fieldwork begun. In this method, analysis and data collection occur in a pulsating fashion. First, one does the interview, then the analysis and theory building, then another interview, and more analysis. It should be noted that most of my interviews were grounded in what happened in classrooms and during professional development sessions. These interviews pushed teachers to reflect in a more in-depth way about what was happening in the project. They also helped to get feedback about how each teacher was making sense of the professional development. For example, I asked the teachers, "how was the meeting for you?" What sense did you make of it? What was

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useful/ not useful to you? How would you want us to structure the meetings next time? I also started the interviews strategically with questions like, "tell me what is happening in your classroom?" This was designed to make the teacher feel at ease during the interview.

As I was collecting data, I was already looking for some patterns, recurrent issues and themes, which might be helpful in guiding my data collection. These were helpful in developing and organizing my questions for the next round / level of interviews. The questions varied from teacher to teacher but were similar in the themes. They depended on what the teacher did in the classroom and her responses to the questions. But I had general guiding questions. Sometimes, I used these and sometimes I just glanced to see if I had covered ground.

Generalizabilty

Generalizabilty is concerned with the extent to which the findings of a study can be applied to other situations (Merriam, 1988). Is this study generalizable? I think it is possible because the findings are based not merely on one case but three. If I had one case, then, it may be difficult for me to generalize and I may have had to regard that as a limitation of the method. Since I have more than one case where the same phenomena was studied, questions asked were grounded on similar issues, and specific procedures for coding and analysis were used. All this enhanced the generalizability of my findings to a theory not to a population (Merriam, 1988; Yin 1994).

Secondly, the teachers I studied were not unusual or atypical compared to other teachers, except for Sarah Williams, who had special education students and a team

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structure that strongly influenced her practice. I am not claiming that these teachers are representative of every school in the nation but they are illustrative of similar situations in other schools. One might argue that it matters that these teachers were white, middle class women in mostly minority and lower class schools. Yes, this might be a factor but it takes the focus of this study in another direction. I think that it is typical to find mostly white, female middle class teachers in middle schools, taking what Lortie (1975) argued that teaching at lower grades was mostly regarded as woman's profession.

Third, unlike survey research which relies on statistical generalizations, case studies rely on analytical generalization where the investigator is striving to generalize particular set of results to some broader theory (Yin, 1994). Along these lines, the findings from my study of three cases may speak to some broader aspects and can be generalized to some broader theory on assessment, professional development and teacher education.

Finally, I believe that even though the findings of this study are based on three cases they contribute to growing literature on assessment, teaching and learning. For example in Wolcott (1973), The focus was the mesolevel, a particular school, but he saw the macro level significance of his ethnographic research as a whole because Bell's school (the school which he studied) was one unit of a national system (Gronn and Ribbins, 1995). In the same way, I too feel that my micro level study of three cases are only three sub units in the school system, but in some ways these three cases can play a significant part in the instruction of the larger education system.

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To summarize, in this chapter, I have introduced the research approach, context and the school settings. I have also discussed the methodology of data collection and described the data management and analysis procedures. I have discussed the generalizability of my findings. In the next three chapters, I present results of the three cases: the Marian Jones case, the Lisa Leslie case and the Sarah Williams case.

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PRESENTATION OF FINDINGS

In chapters 4, 5 and 6, I present case studies of three teachers with whom I worked in this project. I viewed each teacher as a case and therefore I will present each case as a chapter. I will let each case speak for itself. I will not worry about repetitiveness or redundancy because I regard that as confirming evidence to support the claims, assertions and conclusions I draw. In each case I will provide an introduction to the teacher, and describe both her perceptions of her roles and her beliefs about science and or the curriculum, students, teaching, assessment, planning and reflection prior to learning about embedded assessment. Then I will present how the teacher made sense of embedded assessment, what embedded assessment looked like in her classroom, and how this influenced her thinking and teaching practice. Lastly, I will present the tensions or problems the teacher faced as she was in the process of learning and using embedded assessment in her classroom. Chapter 7, will provide a cross case analysis of all the three teachers.

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CHAPTER FOUR: CASE ONE

MARIAN JONES

In this chapter, I will start by giving an introduction to Marian Jones. I will answer the questions: Who is Marian Jones? What kinds of perspectives does she bring to this study? I will then describe how Marian Jones made sense of embedded assessment, what embedded assessment looked like in her classroom and how this influenced her thinking and practice. I will end by describing the tensions, challenges and problems Marian faced in the process of learning and using embedded assessment.

Introducing Marian Jones: A portrait of her views on the subject, students, teaching, learning and assessment

In this section, I describe Marian Jones' views before she learned embedded assessment. I have organized the description under the following themes, which emerged from the data analysis: views about science, teacher role, students, teaching, assessment, planning and reflection.

A) Her views about science as a subject: "This thing has to change"

The subheading "this thing has to change" comes from my first interview with Marian Jones, who has met many people who hate science. She saw herself as a change agent against this hatred. She wanted to motivate students to like science through her teaching. Marian Jones was in her thirties when this study was done. She described herself as 'an older second year teacher', meaning that she is older in age than most second year teachers. This was her second year teaching after an internship at a local

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university. She obtained her bachelors degree in Biology from a small college in the Midwest. After her bachelors degree, she worked at a nature center, a science museum, and recycling organizations. She reported that all these science places gave her experiences that she brought into teaching. For example, having kids work with things instead of just opening a book, means that kids have to work with materials to test ideas. Ms. Jones taught elementary level the previous year as a science specialist and this was her first year teaching middle school. Ms. Jones chose to teach science because while working with science organizations she realized she missed working with kids. In addition, she said,

> ..... *my love of science, and also the fact that when I was at the nature center, and the science museum and things like that, I was seeing how much kids were interested in science, but their teachers or other people who might not have been and so they weren't, I didn't think that they were expanding or pushing them as far as they could,..... but I think there is, that I went into it just to try and get kids more interested in science. Because when I talk about science, or talked about it, when I don't really know, people would ask me what I majored in college and things, and I'll say science major, and they'd say oh I didn't like science, You know I just got that a lot, and I just thought,* ***this thing has to change*** *because science is a cool subject, and so, I want to help bring science to kids, and so they would be more interested in it I guess (MJ/interv1/p05/March 10, 2000).*

Marian believed that science is an interesting subject and so she wanted to pass the love and interest of science to her students. Her high school biology teacher motivated Marian. This teacher had a profound influence on her life through his style of teaching science. He did not give book definitions or answers but pushed his students to think and to do 'hands on and minds on' laboratory experiments. Marian believed that the reason why people hated science was because of the way they were taught science in school. She was aware that this needed to change. Ms Jones saw herself as a change agent and this project was a way of supporting her with that agenda. Another reason why

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she volunteered to participate in this study was because assessment was not covered as deeply or thoroughly as it could have been, or might have been in her teacher preparation program.

B. Marian Jones: "The facilitator": How she saw the role of the teacher

In this section I lay out Marian's views and beliefs about herself and her role as a middle school science teacher. Ms Jones saw her role as that of facilitator of learning. She planned things so that students were working towards getting information, rather than giving them information herself. She wanted to help them discover things and help them make connections.

> *Umm, so helping them, Umm giving them activities or ideas or things to write about, to think about that would help them make connections to other days. Things that we might have done in another day or things they might have at home or ideas that they might have already learned in class that would be, make connections to them and then try and change their own minds about what they think, because I have talked to students, giving them a little speech about this and this and this and you know, this is the way it is, and then kids still believe what they believe. They still have a misconception, and so I am hoping that I can help them think about things more themselves and change their minds, instead of just giving them a bunch of information (MJ/interv1/p14/March 10, 2000).*

Marian offered three ideas about how she saw her role. She wanted to help students:

- make connections across periods and days
- make connections with things with which they were familiar from their home environment and,
- change their naïve conceptions about scientific phenomena, because unless teachers address those "misconceptions", students will still believe them (e.g. Driver, Woods, Squires, 1994).

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She went on to say: "*umm, try to help umm, give them a way to learn other than being just a person that is telling them everything, by giving them all the answers or what ever. Not, umm, and trying to help them be in an atmosphere that and be some place where they can explore more of what they think (MJ/interv1/p14/March 10,2000).*"

Marian wanted her students to explore, based on what they think. She did not want to be a 'teller' of information to her students and she wanted to focus on what students think and to help students make connections. These views provide some insights into the kind of teacher she was. This may be because she was a second year teacher coming out of a teacher education program that focused on student understanding and teacher reflection. She came to this project with a different stance and understanding than other teachers and that placed her ahead of other two teachers in some ways. On the other hand, one might argue that, since Marian was a second year teacher she was "naïve" about school because she was inexperienced and had not been exposed to the realities of classroom life.

C. Teacher's views about students in her class; "They are not being heard"

In this section I will describe Marian's views about her students and their learning, based on my first interview with her. The subheading, 'they are not being heard', comes from the first interview with Marian Jones. She believed that most of her students were not being heard both at school and at home and she wanted to provide a platform where they could be heard. All the students in her classes are from an urban setting and most of them came from lower and lower middle socioeconomic class families. She believed that it was more challenging to teach science to urban students than rural students, because it was

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harder for them to see nature and so they did not have prior knowledge that might aid in understanding scientific concepts. For example, she said,

> *No, I think that that's true that urban students are hard, it's harder to see nature, or what they consider nature in their neighborhoods, and that's another thing that I try to ask them. look at what, what kinds of plants grow around your house? What kinds of animals do live there? What kinds of animals have you seen? And what kind of things to get them to look more around where they live. If you say to a rural student something about cows or deer, or raccoons, or something that's familiar because they are going to see them around the house even, where they live usually, if they are in a rural area (MJ/interv1p17/March 10,2000).*

Marian Jones was aware of the limitations her students had because of their urban home setting (especially during this project time when she was teaching a unit on ecosystems). Their experiences did not give them much contact with nature, which might help in their understanding of scientific concepts. This awareness led her to organize field trips that gave students such experiences, but there were few within a year. Alternatively, it could be argued that saying that students are disadvantaged because they have few experiences with the natural world is a simplistic way of looking at science because science is everywhere, even in the urban settings.

She believed that there were differences among her students in terms of the way they comprehended material that they learned. The teacher has to address all types of learners in her class and be able to push the kids toward an understanding. Ms Jones noticed that some of her students were only present in school physically, not intellectually or emotionally, because there were a lot of things going on outside school that kept them from learning and wanting to learn. She expected her students to be involved learners but she has found out that isn't always what happens. She said,

> *They are not being heard either. So they want to be heard somewhere, so they are heard here. Umm, being receptive to what's going on, being aware of what they need to accomplish. Umm, is, and also having input. That's one thing I'll ask*

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questions and notice that the kids will sit. They won't even try new things. They are not; they won't put themselves out to risk anything. They just want to know the right answer, and if they are given the answer that's fine for them (MJ/interview 1p22/March 2000).

There was a difference between how students perceived their roles and Ms. Jones' expectations. She linked this difference to the problem of what she and they saw as the purpose of school, and also how they have learned how to do school, i.e., taking a passive role and expecting the teacher to provide information. She believed that students tend to resist efforts of being taught differently from the familiar passive role.

She reported that most of the students in her class wanted the right answers, especially the honors students. Yet to her what is important is the process of how to get to the answer rather than the right answer. In some ways this seemed contradictory to her assumption that students wanted to be heard. But they could want to be heard personally, about their lives, and still want to be silent in science.

Ms Jones wanted her students to be interactive and be risk takers. But she complained that they will not take risks, they did not want to look for information, and it was hard for them to synthesize information. Moreover, they did not want to do much work but preferred to sit and have information given to them. Marian believed that students can be able to do all this but they needed an extra push. She said,

They don't want to do that much work. I mean, or they don't know how to do that much work, or one of the teachers made a comment that they don't want to do that much work. They would rather just sit back, and want the information to come to them, and not have to worry, and not have to look for it. But I think that they can look for it, but I just don't think that they have been pushed to do that. So I am trying to push them more to, to do more not, not giving them the right answer, or may be not having the right answer, trying to get them to think more of their opinions and what sense they are making. If you know some facts, what could you come up with because of that, and so that's what I try to do too, or I am trying to do is to push them to look at more data by doing things and then come up with an idea to make a conclusion (MJ/interv1/p22/march 10, 2000).

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Marian Jones was aware of the type of students she had in her class and their attitudes towards learning. She wanted to challenge her students more and embedded assessment was a tool she used. We will later see whether students change their perceptions of their roles.

D. Teacher's views on teaching: "Pushing students further in their understandings"

Ms. Jones tried to bring in situations that were familiar to students in her teaching. For example, when discussing the ecosystems, she asked about animals and plants that were in their backyards. This she believed helped students to grasp concepts, since they already possessed background knowledge. She believed that this also could expose misconceptions or misunderstandings because students make meaning out of their environment or experiences that might be scientifically valid. Marian believed that there were some kinds of knowledge that her students did not have, like the knowledge of the natural world: she also thought that they had some kind of ideas about scientific concepts, which might be naïve in some cases. She did not think that her urban students had the same kinds of knowledge of the natural world as compared to other students who live in different environments. She said,

> *They already have a background knowledge they are bringing to that, Umm, bringing to that idea that you are trying to present, and then that way, if they are bringing that knowledge, you might be able to give them a situation also that would change that, ... that is what I mean by being a facilitator of learning, is helping them push farther, get the misconceptions changed, and try to pull out things they already know, and change it if it's not right or enforce it if it is (MJ/interv1/p16/March 10,2000).*

Marian's views about focusing on what sense students are making and using familiar situations to help students grasp the concepts is compatible with embedded assessment.

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Getting the students involved was important to Marian. She did not want to let students just read a book or see pictures but wanted them active in doing things in the classroom: making simulations; making connections to the real world; making connections with other subject areas; taking field trips that helps them to realize more. Good science teaching from her perspective should address the curriculum, push the students in grasping the ideas instead of memorizing and getting a perfect score on the test. It should take the students a step further in their understanding and not stay in the same position.

> *Good science teaching. Umm, I think that they should I think that they should, you should try to teach what you need to teach in the curriculum, but I think that you need to pull in other subjects to make it more real to the students than just having them memorize a bunch of words and facts, and that kind of thing. But and if the students can get the idea I am more, I am more inclined to say that was effective, if they get the idea of what I am trying to teach them, instead of getting a perfect score on the test. If they grasp more than they did when they started, then I am pushing them in the right direction (MJ/interv1/p9/March 10, 2000).*

So far, Marian's views about science as a subject, her role, students' roles and her views about teaching seemed to be very compatible with ideas underlying embedded assessment, i.e., focusing on the learner and what they say, write or draw in the classroom as a basis for adjusting instruction. In a way, Marian is the "ideal" teacher for this project because of her beliefs about subject matter knowledge, students and how science ought to be taught.

Marian was a second year teacher who seemed to be concerned about teaching and learning and it was difficult for her because of behavior problems and students who were constantly being disruptive. On March 5th, I wrote the following notes in my field book:

> *Students are standing and moving all the time, there is no order in this classroom. It is difficult for me to tell if students are learning... teacher is spending a lot of time on behavior problems... the classroom environment is not conducive to serious thinking although she asked students to do so. Students seem to be very wild today... a lot of*

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Analytical commentary

Even though Marian brought situations that students were familiar with and she tried to make connections to the real world she was having difficulties with classroom management. This may be because this was Marian's first year teaching at a middle school. She had not developed a repertoire of managing her classroom. But we will later see that Marian used embedded assessment to overcome part of her struggles about classroom management.

Marian's views on assessment and embedded assessment

Marian's views on subject matter, students and how they ought to be taught, and her views and her understanding of embedded assessment are compatible with embedded assessment. In her own words, she defined embedded assessment:

> *To me, embedded assessment will be Umm designing a lesson in a way that could assess what the students know as a group, or all of them, instead of just a few. So, embedded assessment to me means you know how each one was doing in the classroom, while you were doing whatever activity you are doing, or part way through your lesson may be, or may be if it's two days, you take or give an assessment at the end of the first day to see what you have to finish, or try and pull some kids along on the second day, but do some more in some areas. And so embedded assessment to me means you are building it in, sort of you are building in the assessment to encourage your teaching to go along with what they already know, or what they don't, or the gaps, fill in the gaps (MJ/interv1/p12/march 10, 2000).*

She also used district tests and end of unit tests and made some of these herself. She gave quizzes; she also used students' assessment of each other such as peer review. These were the forms of assessment she used before learning about embedded assessment. She gave tests and quizzes once a week to figure out if they grasped the concepts for that week so that

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she may revisit it the following week. She had an overall good understanding of embedded assessment based on how she defined embedded assessment in the above quotation, but lacked a sense of the importance of a daily assessment plan. She said that she assessed once a week, but did not see questioning as an assessment opportunity. These ideas changed and evolved gradually as she learned more about how to use embedded assessment in the classroom. In the next section, I describe her views about planning and reflection.

Marian views about Planning and reflection

In her planning, Marian reported that, as a first year middle school science teacher, she had problems in interpreting the curriculum because sometimes it was vague for her to understand it. She also believed that this may be because she was new and lacked experience. Planning was especially challenging for her because it was different from planning for elementary grades where you have children all day. When she was planning she considered time issues, for example, how much time it would take to cover certain areas of the content. She planned a week or so ahead. She used a textbook but felt that this book was weak in certain areas such as giving ideas about connecting children's ideas to their home environment. So, she used other suggested sources for her curriculum. She also considered the "best practice" booklet that teachers in her district were putting together. She also consulted state and national standards and benchmarks. It was interesting to note that her planning did not include the "misconceptions" that she talked about or anything about the learner. So, she did not look up misconceptions in resource books. In interview one, she described how she used some of her resources she got from her teacher preparation program about planning. For example, she read the following questions from her internship file:

I use the following guiding questions from my teacher education classes:

- *What do I want my students to learn, think about as a result of this unit or lesson?*

- *Why do I think these are important?*
- *What do I know about this content and what more do I need to learn and work on in order to teach it?*
- *How will this unit help me address my district curriculum guidelines, state frameworks and national standards?*
- *What resources are available to support my teaching and students' learning? How good are they?*
- *What sequence of activities will help students learn these ideas?*
- *How does this connect with or build on students' interests? (MJ/intrev1/ March 2000)*

Marian reported that she tried to consider these questions in her planning. Looking at these questions helped with a framework she used in her planning. Since she was a beginning teacher, she found these questions very helpful.

Marian like many inexperienced teachers, focused most of her reflections on how she could manage classroom behavior. Marian believed that if she managed students' learning, her problems with managing behavior would lessen. This to me indicated that Marian was seeing a relationship between classroom management and managing a learning community, i.e., if you manage the classroom learning community very well, you will have fewer behavior problems.

Marian's practice before embedded assessment

This section will describe one of Marian's lessons before she learned about embedded assessment. On the board, she wrote the following schedule:

1. Journal: is a food web different from a food chain? How?
2. Food Web activity

Due tomorrow: list of plants and animals around your neighborhood.

The teacher then gave a card that had the name of an organism written on it to every student. She asked the question: What would you eat if you were a consumer, producer.

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She asked the students to write down their answers. She asked students to look at their card and note carefully what they were. The teacher then gave a string and asked students to make a circle of food web. She asked the student to decide where they fitted in the food web. The teacher then said,

> *Teacher: The string represents energy flow and we will have a role-play of a food web. Where will the food web start and where will it go next?*
> *Students (chorus answer): plant, consumer*
> *Teacher: Yes, plants (teacher then directed the activity)*
> *Student: Acorn------squirrel-----snack------hawk*
> *Student: An animal can give you disease (teacher ignores this statement) (FN/March 2000). Teacher then explained to students that there were connected to everything else and asked the following question.*
> *Teacher: What will happen if the producer drops?*
> *Student: This showed us that everything is depended on everything else.*

Analytical commentary

If we look at Marian's views about science, students, teaching, they are compatible with what she was doing in her classroom. She wanted kids to enjoy science, in the role-play just outlined students were interested in this lesson. She wanted to be a facilitator and if we look at the kind of questions and students' responses, we have evidence about that in her practice. She wanted to bring situations which students were familiar to and hence her third item on the class agenda. Her beliefs and views were compatible with her practice and these also seemed to me they were compatible with the embedded assessment project.

3. Marian's journey of the embedded assessment project

I have talked about Marian's views about embedded assessment before beginning the project. Now, I turn to how she made sense of the idea of embedded assessment. I

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Assertion # 1: Mari

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will describe what embedded assessment meant to her. How was Marian making sense of embedded assessment throughout her journey?

Assertion # 1: Marian's journey of the embedded assessment project passed through three phases

Phase 1: Marian understood the basic principles of embedded assessment

Marian passed through phases in her understanding of embedded assessment. In the second interview after just being introduced to the idea of embedded assessment the following quotation explains how she was making sense of embedded assessment.

> *Umm, I think it means that you umm assess students on their knowledge from, it could be a lesson, it could be a project, it could be a key concept that you are going to try to teach. To gauge where they are, and if you have to repeat that again, or em, can move on to the next thing, or may be just get special help for some students that might not understand, because there are a few of those. Umm, and then umm that way you can direct your teaching, and may be change and do something different, for their learning, there may be different strategies to get this concept across, or different approaches, and then may be that way too, you will be able to gauge the kinds of learners you have (MJ/interv2/p33, March 29,2000).*

Key points in her understanding of embedded assessment, as seen in this quote, include:

- Assess students' understanding of knowledge
- Assess where students are in terms of grasping concepts and before you begin teaching a concept
- Use assessment to decide whether to repeat teaching a concept or move on
- Provide special help for some students
- Change teaching strategies/approaches to help them learn
- Gauge the kind of learners you have and know how your students learn best and direct your teaching to what works

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It is interesting to note that her explanation included several things that she did not say in the first interview, i.e., like understanding students' knowledge, paying close attention to the type of learners, and altering teaching strategies. In her first interview, she did not mention that she repeated teaching any concept; she described teaching, testing and then moving on to the next concept. It looked like there was a shift in her views about teaching, learning and assessment. The teacher seemed to have grasped the basic underlying principle about embedded assessment, that it is used to inform her decision making.

Phase # 2; Marian questioned how embedded assessment could be operationalized or enacted and then entered a period of self doubt about her understanding of embedded assessment

As we moved on to interview number three the teacher was having more questions about embedded assessment after having tried it in her classroom several times. Some of the questions include,

> *Right. How do you plan for it first, and then, and then how do you know that that's going to work with this. Do you know what I mean? Do you just try it, and see may be if this assessment isn't a good assessment or, if this is really working? And how would you go back then to say well, I need to do this differently, how else can I do this? I don't know. It's like, it's like may be it is too general, of like oh you can just assess these in different ways (MJ/interv3/p38, April 2000).*

The teacher described three parts that she believed needed to be connected in a cyclical way:

1. Planning for embedded assessment
2. Doing embedded assessment
3. Adjusting lessons

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It seems to me that many good science teachers do step 2, but it is flawed because it is done sporadically, and without phase 1 and 3. Marian appeared to recognize that you needed some skills to be able to identify what will work with your type of students. In the above quotation, Marian struggled about what framework to use for planning successfully for embedded assessment. The other thing that supported the point that she was questioning how embedded assessment could be enacted is the problems and challenges that she was facing. These will be discussed later in this chapter, in the section about tensions and problems.

In interview number 4, the teacher reported that although she had some understanding of what embedded assessment was, she was not sure what exactly embedded assessment was. She said," *It's hard to still, I don't know what it takes, but it's hard for me to see what exactly embedded assessment is" (MJ/interv4/p01/may 8,2000).* She reported that she was working towards embedded assessment, but recognized that she was not there yet. When she was doing embedded assessment she thought about how she could check on what students were doing and thinking and how she could use a discussion instead of written worksheets or how they could check on each other. She had problems in naming what she was doing as embedded assessment. She said, she was thinking about how she could make them interact more and had problems in thinking of what she was doing as embedded assessment because she had a different framework of thinking about it. Marian learned about how to do this through the professional development sessions we had. We gave them examples that were tried and tested by middle school teachers. We also went over the assessment strategies booklet written by middle school teachers in

collaboration with university professors and graduate students. An example, that was discussed in one professional development is given below,

> *The teaching assessment strategy is the Mind stretcher*
> *What is a mind stretcher?*
> *Description: A question or set of questions posed by the teacher that students answer individually, with a relatively brief response.*
> *Uses: Can be used: 1) to develop analytical skills; 2) as a way of making connections between ideas from different class sessions 3) as a springboard for discussions 4) to uncover student misconceptions 5) to sample students' prior knowledge; 6) as a way of introducing students to applications of ideas7) to get kids focused for the beginning of class as part of a plan for behavior management 8) for class closure and summations or lead in for the next days lesson (Assessment strategies booklet, 1997).*

Marian and the other teachers had to read the above description from the assessment booklet and discussed it. An example of how one middle school science teacher used a mind stretcher as an assessment and teaching strategy is given below,

> *In a class of seventh graders, during a unit on the scientific process, the teacher asked students what the relationship is between observation and inference. As examples they discussed the relationship between paper and pencil and horse and carriage before students wrote their answers.*

Marian and others were given actual students' samples of responses and the teacher's analysis, one example is given below,

> *The objective of this task was to have students extend their understanding of the meaning of observation and inference to include the relationships between them. That is, an inference is a proposed explanation of something. That something is often an observation. Of the three students only one student understands this point. The other two do not understand what an inference is. They equate inference with observation, which they define correctly. The teacher had to design another teaching/assessment strategy to help them understand (PD/#3/ April 2000).*

During this discussion Marian was asking all sorts of questions like: *"where is the assessment in this strategy? Why is it considered an assessment and not something*

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like writing what you know? How did this teacher decide what strategy to use next? How different is this from a rubric (PD/2/ March 2000)?

The questions that Marian asked were responded to by other teachers. This helped Marian to gain an understanding of the process of embedded assessment, illustrated in the mind stretcher example, which was:

1) *teacher gathered data by asking students to write*
2) *teacher analyzed that data*
3) *teacher used the analysis to plan what to do next (PD/#2/march 2000)*

The above discussion also gave an example of how Marian was learning about embedded assessment. Marian at this stage tried to design her own assessments like giving mind stretchers before or after teaching, analyzing them and using them as evidence of what her students were understanding. The next section will describe the final phase of Marian's journey through embedded assessment.

Phase # 3; Marian became comfortable in her understanding of what embedded assessment meant but struggled with her mental framework during teaching

In the final phase, Marian believed that she had overcome her doubts and the professional development meetings were helpful in that aspect. In interview number five she talked about this,

> *I think the meeting was helpful and that we could all talk about things in the perspective of being teachers. I know that Dr Gallagher has also given us good examples of embedded assessment. It also helps talking to teachers of the same grade level and the same content and how they are doing embedded assessment. I am a new teacher, so I think I feel I might not know but I feel supported by this group that what I am doing is in the right direction. It did not feel like I had to reinvent my teaching but to work some of these assessment in daily and analyzing the students' samples was most helpful (MJ/ interv 5/p7/ march 2000).*

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Marian reported that there are so many ways of doing embedded assessment but it was sometimes hard for her to plan those before her lesson because she did not know how her students would respond and her mental framework of thinking about this was different from the examples given in the professional development sessions. She reported that sometimes she just decided what to do on the spot and she referred this as happening spontaneously during the lesson and she would be thinking about getting them to think more about the concepts, or pushing them to do something else, or just trying to get them become more responsible of what they are doing. She said,

> *It's more spontaneous, but also it's more like, I am trying to get them think more or push them to do something else but I am not thinking of it as embedded assessment. I am thinking of it as just trying to get them more responsible for what they are doing (MJ/interv4/p03/ May 2000).*

Marian also described embedded assessment as a pool of ideas about how to do activities. She believed it was a bigger idea of how to do those activities and there were different ways one could do embedded assessment. Examples that Marian mentioned are journal writing, mind stretchers, peer analysis, models pictures, diagrams, concept mapping, role-plays, class discussions and inquiry projects. A detailed example of how Marian was using some of these teaching/assessment strategies is given below and it shows a four-day teaching sequence:

Day one

The first day Marian gave her students a group task to brain storm ideas and submit to her so she could analyze and give feedback. The task that was given to students is summarized below,

1. Task for students

- *Discuss a habitat where six animals could live*
- *Write where in the world you could find this habitat and what biome it would be considered.*
- *Name and draw the biome or use pictures*
- *Write down what niche each animal could fill. What is its job? What does it do in the habitat?*
- *Draw a concept map to illustrate the relationships in your biome.*
- *Write down two questions that you have about your biome.*
- *Do some homework to answer your own questions (Field notes/April 2000).*

In the first day students discussed the first four bulleted tasks. While the students were discussing Marian moved around listening and probing what her students were saying. She expected students to individually write the responses and then share with others. Marian took the students' work (individual and group) and analyzed the work. Marian wrote feedback and decided to add the four last bullets in the task. She wanted students to see that everything else is connected by asking them to draw a concept map and thus makes an ecosystem. Marian wrote specific feedback on students' group work and individual journals.

At the end of the first day, Marian had a discussion with me about what was happening in her classroom. I asked her to reflect on her lesson and what occurred. I asked her to specifically talk about how she was using embedded assessment and what her key ideas for this lesson were. This discussion led Marian to come up with the last three bullets above. We also discussed what she was going to do next based on what happened the first day. My role here was not to push or tell Marian what to do but to push her to be more analytical about her teaching and using embedded assessment. I did this by asking questions that caused her to think deeper about the dynamics in her classroom.

Second & third day

Marian discussed one good response with her students. She then asked her students to revise their responses based on the feedback and discussion. Her feedback had comments such as the ones that follow:

> *what other relationships could you identify that are not related to food but are related to shelter or protection? Can you identify relationships that involve non-living things and their environment? Can you explain why this is a biome found in Asia? What makes it different from the biome found elsewhere like in America? You might need some more library work to find out about animals in your biome (FN/ April 2000).*

Students were then given two days to complete this task and prepare for class presentation. Marian gave them a rubric of what she was going to look for in the presentation.

After the second and third day, Marian asked for my reflection about what was happening in her classroom and how she could improve on her use of embedded assessment. I suggested that making her expectations clear would help the students to have a clear focus. Marian then came up with the idea of writing a rubric. Marian also indicated to me that she was being frustrated with the amount of time it was taking to teach the particular key idea. On the other hand she told me that she was pleased that most of her students understood what was taught. We then talked about the advantages and disadvantages of using embedded assessment. After this conversation, Marian was convinced that her goals were in line with slowing down the pace of covering content and helping students to understand science rather than speeding up coverage without comprehension.

Day four

Student presentations

Students presented their work to the whole class. Marian encouraged other students in the class to be actively involved by asking questions, clarifications where they were not clear and to give comments about things they were thinking about during the presentation. Marian listened carefully to the students' explanations and did not disturb. She sat and wrote in her notebook. When I asked about what she was writing she told me that she divided her page into three columns with good points or key ideas, misconceptions and wrong ideas. We both looked at what she wrote and what it told us about students and their understanding of the concepts. We both agreed that there were some groups that had misconceptions. These needed to be revisited before it was late and therefore Marian planned the next day based on what she wrote during the presentation. We also discussed what a suitable strategy would be for the next day. We agreed that a class discussion would be the most appropriate and Marian would use her notes that she wrote as a focus for the discussion.

Analytical commentary

In analyzing Marian's teaching above, I see Marian as an **investigator** of her students' ideas (brain storming, presentation, written work, concept map). All these products of students' work gave her information about what her students were thinking, what they understood and what they were confused about. She analyzed that information so that she could **design** what to do next. Marian **evaluated** whether her teaching strategies worked for her students and tried to design others that could help them move further in their understanding. In investigating, designing and evaluating her teaching strategies Marian was using embedded assessment.

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Marian Jones was realizing that she needed to consciously take the information she had gathered through the use of embedded assessment and use that in her teaching. She was still learning how to do that effectively. Marian reported that she saw a connection between using embedded assessment and teaching for understanding. She said,

> *"There is a connection between embedded assessment and teaching for understanding because of the fact that embedded assessment helps them explain or share or do something themselves which helps them put it into their own words, or their own knowledge of how something is done, and then help them make it their own learning, or their own ideas" (MJ/interv4/p24/May 8, 2000).*

Marian Jones saw embedded assessment as a tool that helped her to teach for understanding. She believed that to make embedded assessment really work you have to use their work and their thinking and assess where they are. She believed that in order to do this you have to ask the right questions that reveal or show kids' understanding or knowledge. In interview 5& 6, Marian was shifting towards being comfortable with using embedded assessment and realized that in order to do embedded assessment teachers must have strong subject matter knowledge. She said,

> *I am very comfortable with the ecosystems unit and using embedded assessment for this unit because I was Biology major and I worked at the nature center. This helps me do embedded assessment well because I can say if they don't get this I could do this and that because I am comfortable with the content knowledge so I can look at it in different ways and I have done more with it. But force and motion, I have never had physics so that's one of the things I am looking to do a masters, going more into more subject content. I can see that to gauge what students write or say by using embedded assessment, I will need to know a lot of content knowledge because how can the blind lead the blind (MJ/ interv6/p35/ June 2000).*

Marian realized that to investigate what her students knew she herself must know the subject matter well enough to do that. Marian was aware that her subject matter knowledge in some areas of physics was weak and therefore these were the areas which she might have challenges using embedded assessment. Marian reported that she was

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planning to improve her content knowledge in these areas by going back to do a graduate level classes in science content. This disposition appears to give us an indication about what kind of teacher she was and she will become. To me, this shows me that Marian examined her weaknesses but did not sit on them. She sought ways to keep improving herself as a teacher.

Analytical summary of Marian's journey

I have described the three phases that Marian passed though as she learned embedded assessment. Firstly, she started by responding well that she understood the principles of embedded assessment. Marian embraced these because these were some of the ideas that were focused on in her teacher preparation program for example, finding out what students were thinking. Then, she tried embedded assessment in the classroom and had many questions about it. These appeared to be due to how she was thinking and the problems she was facing. Marian began to doubt whether she really understood embedded assessment because of her thinking framework. The professional development meetings and my conversations with her immediately after lessons helped Marian with her questions and doubts. Marian felt energized by the support she got from the professional development and continued doing embedded assessment. Marian seemed to be more comfortable with embedded assessment but she still continued to struggle with her mental framework during teaching. Marian began to use embedded assessment continuously in 3 or four lessons. Her understanding of embedded assessment was becoming complex and it was also evident in her teaching. Marian continued to do

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Assertion # 2: Embedded assessment took many shapes in Marian's classroom

The following section will give a table which shows the many forms that embedded assessment (EA) took in Marian's classroom during her journey of the embedded assessment project. These are excerpts from my observation notes taken at different times.

Table 4.1 Summary of observation notes about Marian Jones: An illustration of the forms of embedded assessment used by Marian

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Date	Observations/Teaching strategies/Forms of EA	Topics and observer's perspective of what is the form of EA	Reflections of the observer
03/07/00	Students do individual work about what they would eat if they were a consumer, producer, etc, and then students make a circle of food web as a class. This was a role play of a food web	Food webs. Marian was using **role play** as an assessment and teaching strategy	Teacher says, "I am not seeing serious thinking going on. The types of questions asked do not require thinking and the classroom environment is not conducive to 'serious thinking'. The number of students in this class is 28 and when you have large numbers, it's a good opportunity to socialize. We need to think about how we can make classrooms conducive to thinking. One idea is to reduce class size and to change questioning techniques.
03/08/00	Reading and little of class discussion	Energy pathways Marian is using **class discussion** as a teaching and assessment strategy	Students asked questions a lot this day and teacher seemed uncomfortable with subject matter as indicated by "I did not write the book" and not being able to probe students or answer some questions. When a student argued about what he thought about the pond ecosystem; teacher saw this as challenging – whilst I saw it as a good sign in that the student is thinking about what they are learning.

03/29/00	Individual drawing of habitat where 6 animals can survive and predicting where in the world the habitat could be found and what biome it would be considered-niche. Students asked to draw a concept map to illustrate relationships in the biome. Journal grading procedures	Habitats, biomes, niches. Marian used **drawings/posters and concept maps** as assessment and teaching strategy	Most students seem to enjoy drawing. Individual students asked for tr. help- she asked them specific questions like –where is the food and animals- do more on your chart. Students are expected to grade their journals and the teacher will look at the grading; teacher gave explanations of how to grade the journal.
03/30/00	Students hang their picture on the wall and are to discuss similarities And differences.	Different Types of Biomes. Marian used **peer analysis as teaching** and assessment strategy	There was a lot of participation from the class today maybe because the class discussion is based on their work and ideas rather than abstract concepts from the textbook.
04/11/00	Reading for information. Students are expected to read and answer questions from the book as a review for the test on Friday. Students will exchange papers and correct each	Ecosystems. Marian used **Peer review** as an assessment strategy	The teacher is using this to further clarify the main key ideas e.g. predator-prey interactions, carnivores, herbivores, primary and secondary consumers. Some students finish faster than others and do not want to do anything after this. There are some students like Angela who seem to like tr. attention and need help all the

	other's work.		time. I was not sure whether these students are able to do a peer review of work and I was expecting a discussion that will guide students as they correct each other's work. Reading for information-I think this need to be taught because it is often assumed that students know how to do this well.
04/12/00	Students read the information in the text, the teacher presented a problem that students are expected to work on and should answer the questions on a worksheet. Teacher then led a class discussion.	Gradual re-forestation succession. **Class discussion**	Tr. explained to me that this is a challenging task that focused on students' understanding of the topic and it integrates mathematical skills. Students were participating a lot during class discussion and some of their ideas on why people cut trees were: - to make furniture, people are stupid-they cut trees to get what they want, they cut trees for natural gas, to put underground pipes, for farms etc
04/20/00	Students examined each other's models of cells. They looked very inquisitively at the cell models. Student then evaluated the models by writing one thing they liked about the model and one thing that could be improved.	Cell models **Models**	Students were creative in coming up with cell models they were all different. Most students put a lot of time into this assignment and most of the models demonstrated clearly the structure of cells mostly plant cells. I was impressed with how they were focused today and it seems there is a pattern developing here that is if students are looking at a product of their own their interest level goes up.

04/25/00	Students are to pretend that them and their friends are making a biosphere proposal to the U united nations and teacher gave specific questions to think about e.g. how will the plants survive? What foods will you need? Students wrote a report based on the answers and then presented their report and compared to that of others.	Biospheres **Student presentations**	This is a good example of how embedded assessment looks like for this teacher. During presentations Ms Jones was writing down good points and misconceptions said in the presentations, which she visited the following day. She also stressed the key ideas that she wrote form their reports as a confirmation of their work.
05/02/00	Students start the day by answering a journal question of how photosynthesis takes place in a plant and then the teacher leads a class discussion about photosynthesis with intervals of peer discussion of questions asked	Photosynthesis **Journal writing**	Some examples of questions asked are: - what do you need for photosynthesis to take place? Where does photosynthesis happen? How does Co2 get to the stomata? How does sunlight get there? Label all parts involved? How does the plant deal with products of the photosynthetic reaction?
05/03/00	Word search and fill in.	Photosynthesis	This worksheet was designed to help students remember the vocabulary used in the photosynthesis unit.
05/17/00	Triangles and measuring	Mathematical	This lesson was designed to help students

		skills **Field Trip**	with their mathematical skills in preparation for the field trip at the Michigan adventure park.

The above table shows the type of assessment strategies that were used by Marian and my reflections about it. Some of things that were interesting from the tables are: - On march 7, this was the time when the teacher had not learned about embedded assessment and I saw that she was asking low level questions. Some of the questions she asked I thought there were a compromise and used as a classroom management technique. When I asked her about this, she said she was still in the process of developing her questioning technique. On march 8, the teacher seemed uncomfortable with the subject matter and therefore could not answer questions asked by students. It is interesting to note that there were some differences and similarities between the teacher's understanding of embedded assessment and what she did in her classroom. These will be discussed in detail in the discussion section. What are the forms of assessment the teacher used? I have highlighted them in the table. They were role-play, class discussions, drawings, posters, concept maps, peer analysis, peer review and models. Marian seemed to be adding to her knowledge of teaching strategies and was learning how to use these as assessment strategies.

The shapes refer to oral discussions, written work, drawings and reading and use of different teaching strategies that showed the teacher what her students really knew and what she could do about it. How did all this learning about embedded assessment and using different forms of teaching and assessment strategy influence Marian's practice and thinking? The following section will describe the impact of embedded assessment.

Impact of embedded assessment

Assertion # 3: Embedded assessment affected Marian's views about curriculum, teaching and assessment in ways that she viewed as beneficial for her and her students.

So far, I have discussed Marian's understanding of embedded assessment and how she enacted that understanding. I have also provided some specific examples of assessments she used in the above table and in the section on the phases of Marian's journey, I have described what students' work or tasks were and how she interpreted it and made decisions in the examples of her four day teaching sequence, now I will provide how all this impacted Marian's views and her practice. The following section will look at Marian's views about the impact of embedded assessment on a) the science curriculum, b) her classroom and her students, c) teaching and her views about her role ,d) planning and reflection ,e) how she used assessment, and f) Teaching strategies and teaching for understanding. I will end with an analytical summary of the impact of embedded assessment as a whole.

Impact of embedded assessment on Marian Jones's views about science curriculum

Marian was focusing on key ideas or key concepts each week. She was organizing her curriculum in that she taught a few key ideas each week and this she reported was supported by David Sousa's work on how the brain works *(Marian attended a brain research workshop by David Sousa during the study).* She believed that this helped

students understand. They were not overwhelmed with a lot of stuff and it helped to keep their interest going.

> *Because I am finding that if you sort of chunk it more, and that's what you talked about too, brain research, if you, you put it sort of together in a package like this week we are going to learn about these concepts, and next week we learn about these concepts. And so have them concentrate, right. And have them concentrate on those just that week, and then try and put them together as you go, or else put them together at and or you know somehow give them less information at a time, and so they are not overwhelmed with the lot of stuff they need to know. Interest keeps going along (MJ/interv2/p17/March29, 2000).*

Marian was now packaging her curriculum with her students in mind and therefore adjusting curriculum to their needs. In using embedded assessment the teacher was using more of their work and their thinking as the basis for selecting what to teach and how to teach it.

She was also mindful of how concepts connect to each other and that means that she was not teaching discrete pieces of information. She used embedded assessment to see if students grasped those key concepts and the connections among them. She was covering fewer topics each week and this slowed down the pace at which she was covering the content. (We will see later (section on Problems) how this becomes problematic for her.)

b) Impact of embedded assessment on Marian's classroom and her students

1. Student talk

Marian was having students talk more about scientific ideas in her classroom and sharing with each other about what they were doing. She believed that talking makes kids remember concepts and therefore she required students to work in groups and do oral presentations to the whole class. She believed that talking helps understanding because you are expressing how you are making sense of what you are learning to others who

confirm or can correct your ideas. It also revealed to her how students were thinking, and what misconceptions they had so she could address them and it helped students make connections, something that Marian talked passionately about.

> *That was one of the things that, the brain research, the guy with the brain research ideas David Sousa.... He was talking more about talking helps you remember too,..... . I noticed too, because I did a project with them when they had to do presentations. The students had to keep track of what other students said. So there were like nine or ten things that they needed to cover. They needed to cover like planet size, or planet temperature. So, they were actively listening. They had to check it up, and give them a grade based on what they said and did or say in their presentation. And so, that really helped, and that really went very well I think. Students really wanted to present. I don't think I had a student that had a failing grade on that presentation, because they really wanted to do a good job...and em, and I think talking it out helped them understand (MJ/interv2/p23/March 29, 2000).*

Marian was linking encouraging students to talk and express their ideas with work done by brain researchers. In traditional classrooms it is the teacher who talks more but Marian argued that the person who talks more was the one that will ultimately understand more and she based this argument on brain research work. She saw a need to give students a platform to talk and express what they knew and she believed that this allowed her to assess their knowledge even without a written assignment.

> *So, that's, that's another thing too I think that, that it's sort of embedded assessment when you start listening for them to use that language, you know vocabulary, without actually doing, I mean actually doing an assignment, but when you hear them start answering in the vocabulary that you are trying to teach them in the right way, I think that that's also an embedded assessment in the discussion and some kind of question, answer oral thing is going on too. So that's exciting too. ...Try to use. They were not using it exactly, but they know it's that P you know the P-word (MJ/interv2/p05/March 29, 2000).*

Marian was excited that students were able to use the scientific vocabulary in their talk. The teacher saw a connection between embedded assessment and having student talk. She used talking as a way to gauge their understanding so she could tailor

make her next instructional move. Through talking the teacher was able to find out what students understood and what they did not understand so she could decide in that moment of teaching whether to change her lesson plan or move on. The following section on Marian's teaching will give evidence for the claims made above. (The following will give field notes I wrote on April 12, 2000)

Marian wrote the schedule for the day, which was:

- *Read page 46-53*
- *Answer the questions on the board (FN/April 2000)*

Marian told me that this was supposed to be a challenging task that focused on students' understanding of the topic succession and it also integrated mathematical skills, i.e., graphing and interpreting it and use of pie charts. (FN/April 2000)

The questions that she wrote on the board were:

a) What kind of information can you get from reading these pie charts?
b) What observation can you make about the recovery process of this region of the forest?
c) Why do you think the amount of Lichens and mosses decrease from 1991 to 1996?
d) Will this forest recover?
e) Can you think of circumstances in which Ross would observe opposite results (FN/ April 2000)?

I wrote the following notes in my journal:

Role of the teacher today: Presented problems that students are expected to work on and she moved around and noticed that some students were having difficulties. This is when she used embedded assessment to stop and have a discussion so as to help with those difficulties. Role of the student: they were to read and analyze graphs and pie charts and then answer the questions (FN/April 2000).

After this lesson, I had conversations with Marian and she reported to me that if she had not learned about embedded assessment she would have let the students continue

and then move on to the next topic the next day. The following is a class discussion that Marian had to help the students who were struggling to understand the text.

Marian; What is the key idea of the text you have just read?
Student: Gradual reforestation
Another student: Succession
Marian: Look at the graphs and the pie charts and I want you to fill in this table.

Type of land	*1991*	*1996*
Large deciduous trees	*40*	*50*
Wild grasses	*20*	*30*
Lichens/Mosses	*25*	*10*
Barren land	*15*	*10*

Marian: What was this person studying?
Student: Forests
Another student: Deforestation
Marian: What is deforestation?
Students: It means forests dying?
Marian: Why would one cut trees?
Student: For making furniture
Another student: For making paper.
Another student: People cut trees because people are stupid, they cut tress to get what they want.
Marian: Up north they cut trees for natural gas and they cut trees to put underground pipes, people also cut trees for farming.
Marian: What does barren land mean?
Student: It means there is nothing there.
Marian: What are mosses?
Student: grass that is carpet like.
Marian: What are deciduous trees?
Student: These are trees that lose their leaves. (FN/April 2000)

Marian reported that this conversation was necessary to enable most of her students to understand the text and to interpret the graphs so they will be able to answer the questions. From the answers she got she was able to have evidence that most of her students understood the text and the topic of deforestation. Some examples of what students wrote for question a) and b) is given below,

- *" I got more or less of trees, this is the information I get from reading the pie chart.*

- *Large deciduous trees increase by 10, wild grasses increase by 10. Lichens decrease by 15 and the barren land decreases by 5.*
- *It will take time for the forest to recover because it takes a longer time for the trees to grow." (FN/ April 2000)*

Marian reported that the class discussion helped her and her students. It helped her to judge whether they could pick up the key ideas in the text. It helped her to see whether they understood what was going on in the pie charts and graphs. When she was moving around she noticed that some of her students had poor mathematical skills and therefore drawing the table was helpful for those students. Marian believed that the class discussion helped with the vocabulary word, which she had assumed they knew. She reported that because one student had referred to the point that 'people are stupid because they cut trees', the next day she was going to start the class using the student notion as a point of debate. She said that if that conversation had not occurred she would not have thought about that. The next section describes that Marian is not only letting students talk but she was also listening carefully. It also describes why Marian thought listening was important for her and particularly in doing embedded assessment.

2. Marian was listening to students' talk

Marian was not only allowing students to talk but she was listening carefully to what they were saying, in her own words she said: "*Let them talk more and you listen carefully" (MJ/ interv2/p28/ March 29, 2000).* Unlike traditional classrooms, Marian was listening to what students were saying (in traditional classes its usually the students who spend their

time listening to the teacher most of the time). Marian argued that If you do not listen it is not easy to see how students are making sense of the scientific concepts. In most classrooms, teachers listen to correct what is wrong but Marian was listening to see how students are reasoning. In that process she could help them in their reasoning not by giving right answers, but by asking more questions that help the students to build their own answers.[1]

Marian believed that students respond positively when teachers listen to them. In her words she said:

> *"That you are listening to them helps with value. It helps with their self-esteem as well as their schoolwork... Some students really want to share more. I think a lot of these students don't get anything at home, or they do not get a share in time, or their parents may not listen to them very much at all. So, I think it helps them know that somebody is listening to them because of value. Valuing what they say helps with behavior, because they want to participate now instead of just sitting there" (MJ/interv5/p17/ May 8, 2000).*

Here, we see Marian recognizing that having students talk about their ideas served multiple goals. They feel valued, their self-esteem improves, they want to participate, their behavior improves and she learned about what they understood. Therefore, the project was having a positive influence on some students. The teacher was valuing students' contribution in class by listening and incorporating their ideas during class discussions, thus she believed that students respond when teachers listen to them. They become more willing to share their ideas and their thoughts and this she said helps with their self-esteem as well as their schoolwork. Valuing students' ideas helps with behavior because students want to participate in classroom activities and sometimes the reason why they act out is because they are bored by just sitting and listening (being passive). She mentioned that most of her students come from home environments where their

[1] Constructivist theories of how people learn support Marian's argument here. Constructivist learning theories argue that people learn

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voices were not heard and it helps if someone at school listens and values what they say. The next section will discuss the influence of embedded assessment on Marian's planning.

3. Marian was planning " on the floor"

Marian reported that listening to students' ideas has helped her in her planning because some kids might say something that sparks the way that she might plan for future lessons.

> *If I am in the flow of the classroom and talking to students, when they are giving me ideas, or answers to some questions, whatever, sometimes there will be an idea that I did not think of when I was planning by myself and away somewhere. Sometimes it's the action room, you know the classroom and the kids in the situations that will come up or sometimes it will be something that somebody else asked that sparks my mind about doing an activity in a different way.... and some of my best ideas have come that way (MJ/interv5/p30-31).*

She called this "planning on the floor" which she defined as planning whilst teaching in the classroom with students. While doing activities or discussions, ideas spark for her. So, the floor is the classroom context, and what goes on in her mind about what is happening during class. This I think is the crux of embedded assessment because you might not have thought about teaching it that way. Since she started using embedded assessment it has helped her to think of ways to adjust during the lesson and for future lessons. A good example of this is when she was talking about allowing kids to talk. One student talked about his idea that people are foolish because they cut trees. This idea made her to think about turning this student idea into a debate. (For details revisit page 97) The next section will describe the impact of embedded assessment on classroom interactions.

4. Classroom interactions

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by constructing knowledge not by being given knowledge.

Because Marian was allowing students to talk and she was also listening actively to that talk this caused her to think of what next she could do, interactions in her classroom changed.

> ..... *because you are listening to the kids, and they are actually, inputting their ideas in. Umm, I think that, the classroom evolved into something that was more, which was more Umm; I don't know how to explain it. More like higher level thinking, more ...questioning from the students to students, and students to teacher, but more student-to-student interaction. Umm, on a higher level. I don't know how to explain it, like.... (MJ/interv5/p20/May 2000).*

Embedded assessment was influencing the classroom interactions in that the kinds of questions that were asked and answered were at a higher level of thinking, there was more questioning from student to student and student to teacher and vice versa. There were discussions of more constructive ideas that lead to more application and understanding.

An example that supports the claims made above from Marian's teaching is described below,

Marian asked her students to pretend that they were a group of friends that have decided to make a biosphere proposal to the United Nations. They were asked to consider the following questions:

"*1. How will you control temperatures?*
2. What will happen to wastes?
3. Where will fresh water and fresh air come from?
4. How will the plants survive? What foods will you need? Make a list of ten nutritious items.
5. What is the natural source of each of each of the foods on your list?
6. What will your biosphere have to include so that you can have a continuous supply of food
7. List everything you would need in order to support the food producing plants and animals.
Write a report based on your answers. Then present you report and compare it with those of other groups. You might want to change some of your answers after listening to other groups.

Marian noticed that students' presentations had a lot of misconceptions for example that 'dirt is food for the plant'. She told me that she was going to address the misconceptions after all the groups had presented. This example has shown us the kinds of interaction that Marian was having in her class. In the above example, there were interactions of student to student and student to teacher and the task that she designed was at a higher cognitive level. Marian reported the embedded assessment project had influenced her to think of activities that will cause more interactions in her classroom. I will now turn specifically to describe what the impact of embedded assessment was on Marian's teaching.

c) Teaching

The following section will describe the influence of embedded assessment on Marian's teaching. Marian believed that embedded assessment helped her to teach for understanding.

1. Embedded assessment helped Marian achieve her goal to teach for understanding

In the first interview I had with Marian she indicated that one of her goals was to teach for understanding and not memorization of facts. She believed that, *"There is always a way to explain things differently so people can understand" (MJ/ interv2/p28/ March 29, 2000).* One of the things that Marian was doing in her classroom was finding ways students could learn scientific phenomena using different teaching strategies that she believed will help in understanding science. Examples of the kind of strategies she was using are journals, presentations, class discussions, peer reviews, role-plays, simulations and illustrations (See table 4.1 on page 83). These examples are the kinds that enable kids to be actively involved physically and mentally in the classroom. She believed that using

embedded assessment enabled her to teach for understanding as she was paying a close attention to student thinking about what she was teaching and how she could push that thinking. However, she had noticed that students just wanted to know the answer instead of understanding.

> *When you say understanding it, that is different than knowing. To me, knowing the stuff is different than understanding. Understanding, you make more connections.* ***And I think embedded assessment helps you do more understanding than just knowing it.*** *And I think a lot of kids just want to know it, get the test over with and get to that, you know. They just want to know it for that. They don't really want to understand it. They really don't care. You know what I mean? There is no relevance to that" (MJ/interv5/p17/May 2000).*

So, even though Marian was using embedded assessment to find out what her students were thinking and adjusting the curriculum and her teaching to help students learn with understanding, she was still encountering problems related to students' own purposes. This was a challenge I will discuss further in the section on problems.

Marian believed that there was a connection between embedded assessment and teaching for understanding. She said,

> *There is a connection between embedded assessment and teaching for understanding because it helps students explain or share or do something, putting it in their own words or personal knowledge on how things are done and this way they will be making their own learning and I can help (MJ/interv5/p24/May 2000).*

Marian thought that embedded assessment is connected to teaching for understanding because it enabled her to get evidence about how students made sense of science so she could help them. Marian believed that one aspect that is important in any assessment is questioning and in the next section I will describe the impact of embedded assessment on Marian's questioning skills.

2.Questioning

Marian emphasized the point that when you teach for understanding you have to learn how to question for understanding, not just for one-word answers. You have to ask questions that reveal what students really know, and yet she did not know how to do that. (In the project, we had assumed that all teachers knew). She needed to learn how to do that and her students need to learn how to answer her questions. She said,

> *It (lesson) went pretty well. I think that I am getting better. I am, I understand that they need more preparation too. And I need to, you know I need to work on things, but they need to be able to understand that. You know, what I am asking them they need to completely answer too. I mean, some of them would just like answer incomplete sentences. Like pulling teeth, and Umm, and so I think that you need to train them as well (MJ/intrev5/p33/May 2000).*

Through embedded assessment, the teacher noticed that her questioning skills needed improvement. She believed that questioning to find out how her students were making sense of science required more skills. Because you have to take what they know and what you think they do not know and generate helpful questions. She referred to these kinds of questions as learning or thinking questions. She reported that this was taking more of her energy, time and it was a skill she needed to develop. In the last interview she commented,

> *That's one thing I think that I noticed that wasn't as good as I, as you think it is. You can ask, you can try and ask questions, but sometimes they are not as good, or they are not the right question, as hard, because it takes a lot more energy, a lot more planning to be able to do, take what they know, or take what they don't know, and try and pull it apart, and ask the right question, and come back the next day be able to ask learning questions. Or even, at the end of the week, or what ever, and ask the right questions. And that's one of the things too, is that umm, that ...assessments that are basically asking the questions. You have to ask the right question, to be able to see if that's what they really understand. Because a lot of the assessments I notice it's like give the district assessments, the question, it was okay but they weren't really testing what they wanted them to know (MJ/ interv6/p09/ June 2000).*

Marian saw the importance of how you word the questions. She believed that to really reveal students understanding the teacher has to be thoughtful about the kinds of questions she asks. This she said, was a challenge for her. In some of the lessons I observed she will reword the question 3 times but the more she tried to change the wording the more it moved away from being a thinking or learning question and became sort of leading. She commented,

> *Like asking question or, figuring out how umm, how to direct, without directing, without taking over and lecturing, because it seems like umm, it would seem like umm sort of in between, like I try to discuss things, and then they would go where I want them to go, or where we need to go. I don't know how to get it there, and so I just started telling them what they needed to know, because it's easier, but I don't know. I think that's that's bad, I mean not bad, but I mean I don't think it's as good, ...you know using more of their information, thinking about it more, how could you do this, and that's one of the things you already know, and building on that, so (MJ/interv6/p13&14/June 2000).*

Marian was not very confident about her ability to question well. Here, she was struggling with balancing these ideas about using questioning as a form of embedded assessment.

4.Assessment

Marian was not focusing on grading each and every student work she collected. She was using some of it to search for understanding/misconceptions. Marian reported that she was trying to do more of assessing daily. Some of this assessment was through oral discussions and or drawings and written tasks. But her main focus was that she wanted to have evidence of learning from her students daily. An example she gave was journal writings with questions like what are some main points you got out of your science lesson today, what are some things you are still puzzled about, do you have some questions about the science you learned today. As we have seen, Marian reported that she

was allowing students to talk more instead of just having them do their work individually and get a grade but she realized that students want a grade rather than just written feedback and are therefore they are a factor in the implementation phase. She also reported that using embedded assessment was a challenge for her because of the number of students in her class. She had 125 kids and to thoroughly check for understanding for all of them was a challenging task. So, sometimes she picked a sample of students and used their work as a representative sample to analyze instead of all 125 kids. The next section will look at how Marian's planning changed.

5. Planning and Reflection

Since learning about embedded assessment Marian's planning had changed. She reported the following points about her planning,

- She thought about how students will express what they know for each day/key idea/unit (interv 3/p/23/March 2000)
- She was giving more thought in her planning basing on previous happenings in the classrooms such as how her students responded to questions asked (interv3)
- She considered Megose and the District curriculum (intrev3)
- She thought about how she could use a variety of teaching strategies instead of one approach and finding teaching strategies that would motivate students and also that would reveal students' ideas to her. (intrev4)
- After each lesson she assessed if her students 'got it' by reflecting on what happened in class/what the students write and she tried to push them further in their understanding the following day. (interv6)

In her own words, Marian described her planning process:

> *Like umm, like giving them more things, make sure they have lots of things to do, and keeping them busy, and then trying to use embedded assessment to keep that in mind as I am planning to give enough time too. So I want to keep them active in what they are doing, but then I also want to have some way to have them express what ever it is that they have done in embedded assessment. So I guess, I, I am probably using for planning more, and more reflective of the idea that I need to leave a little bit more time to get what they know or to assess what ever they are talking about or, and em, but I also have to have enough things that they are doing something, it's not just oh we are doing this. You know, we are sharing this, and it is boring, and, I mean there has got to be a variety, but there is also, there has to be in what you are doing, how you are assessing it I think, a variety of things, instead of just having a bunch of discussions or a bunch of tests, or em, and so, I think that way planning, sort of more stuck, not it's already structured, but more em, I don't know how to describe it, more* ***thought out****, I guess. Umm, well if we do this here, then this will work here... I think I did some of this before, but I think it's more systematic and I am trying to use time more effectively (MJ/interv6/p17/June 2000).*

Now that she had learned about embedded assessment, her planning was now focused on what her students wrote, what her students were saying, and she was no longer focusing on covering the objective. So, in her planning, she was looking at her students' work, and saying, okay, with this that they have written –what can I do? So, it's now focused on students' ideas i.e. what they write or say in class.

I will give a summary of the impact of embedded assessment on Marian's planning and reflection in the table.

Table 4.3 Summary of the impact of embedded assessment on Marian's planning and reflection

Before embedded assessment	After embedded assessment
• considers how much time it will take to teach particular concepts • plans a week or so ahead • uses textbook (science plus) • She uses standards and benchmarks • Reflection mostly focuses on classroom management issues • follows the district guidelines in her planning	• plans 'on the floor' meaning planning whilst teaching • thinks about how students will express what they know for each day /or key idea (what is the evidence of learning) • planning is based on previous happenings in class • considers what the best teaching/assessment strategy will be and uses a variety of strategies • Reflection done daily and also considers student writing and pushing understanding

In the table above it is visible clear that embedded assessment had a notably influence on Marian's planning and reflection.

Analytical Summary on the Impact of Embedded Assessment: - The Marian Jones Case

Marian Jones was a second year middle school science teacher who started this project with a compatible stance on what the embedded assessment project required her to do, in terms of her beliefs and views about teaching, learning and assessment. I have also throughout given examples of the kinds of assessments she designed and gave and what happened in her classroom. She worked very hard to learn and do the embedded assessments. Embedded assessment gave her a tool that enabled her to become the kind

of teacher she wanted to be. Although she experienced challenges and tensions, which will be my next section of discussion, this project influenced her, her students and her classroom in a positive manner. She believed that embedded assessment was a tool that helped her to teach for understanding and application. Why do I say positive? She wanted to avoid telling kids the right answer. She wanted to push students to think and experience "real" learning. She wanted kids to understand science and be interested in learning science.

This project raised her awareness about embedded assessment and how it is done in the classroom. This is important because in the beginning of the study Marian was unaware of embedded assessment in the classroom and not sure what embedded assessment meant. Marian was doing embedded assessment but was not always aware of exactly what she was doing that could be called embedded assessment. The increased awareness of embedded assessment enabled Marian to reflect in new ways about her practice. I perceive this as a main aspect of her development.

Another important feature of Marian's use of embedded assessment was the purposeful actions she took to do embedded assessment. Assessment became an integral part of her teaching and learning. The use of assessment this way made her teaching responsive to students. Marian claimed that embedded assessment helped her teach for understanding and therefore promoted science learning. She saw the importance of encouraging students to talk, express their ideas and to communicate constructed meanings and to give feedback.

But Marian discovered that teaching using embedded assessment had its own challenges. Using embedded assessment was influencing the way she thought first and

then what she did in the classroom, but they are trade-offs to using assessment this way.[2] The next section will examine the problems, challenges, tensions that Marian faced in her journey of the embedded assessment project.

Assertion # 4 In the process of learning about and using embedded assessment Marian faced challenges/problems and tensions

I have discussed how embedded assessment influenced Marian's views about the curriculum, students, teaching and assessment and the classroom environment, I now turn to the kind of problems, tensions and challenges Marian faced as she tried to understand and use embedded assessment in her classroom. The discussion in this section will look at problems that relate to: a) curriculum, b) students, c) teaching, d) assessment, and e) contextual issues and professional development.

A) Tensions that relate to the curriculum

1. Strong subject matter knowledge

Marian Jones believed that to use embedded assessment effectively, you must have strong subject matter knowledge. If the content knowledge is weak, she said there will be a problem of the "blind leading the blind" they will never get to the destination.

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[2] Krapfel ,1989-
"Evolution is the process by which the impossible becomes possible through small accumulating shifts. Concentrate on the direction, not the size of change. Begin with actions that seem tinier than necessary but which are small enough to be maintained. The rate of change is slow at first but do not prematurely judge your efforts. Change happens through spirals; the work grows upon itself. As little changes accumulate they will reinforce one another and make larger changes possible. (p.176) Marian's story is a story about change and Krapfel's argument fits her journey of the embedded assessment project.

She noticed that because her content knowledge was weaker in physical sciences than in life science; it was easier for her to use embedded assessment in the life science units than in the physical sciences units.

> *If you do not have the content background, or as much knowledge, you are learning with them, I think it's harder to do because you are not always sure that that's right, or that is closer to being right.....unless you are ahead of them, a little bit somehow. But even then, I've noticed, because I have had to teach both life and physical sciences, that life science is easier because I am more confident in the content in life sciences. So, if they are saying something, I can kind of see where they are misinterpreting it because I can see the whole topic or whole concept. I can see what they are thinking, misunderstanding whereas if its physical science, I am seeing it from one side more, and they might be on the other side and it is difficult for me to see what they are thinking and to help them understand it more because I do not have a complete understanding of it all, so I think its more difficult (MJ/interv6/p07/ June 2000).*

Marian explained that strong subject matter knowledge enabled her to spot misconceptions, to see the bigger picture so you can help students to that picture. Marian was seeing that it would be quite difficult for the teacher to use embedded assessment if their content knowledge was weak. Even though her beliefs and views of teaching were compatible with the views of the project, she was limited in some topics in her ability to pull it off because of subject matter limitations.

2. Time versus amount of content

Marian complained that teaching using embedded assessment was time consuming. In her district they were given a list of objectives they were supposed to cover but when she started using embedded assessment she slowed down the pace. She was unable to cover all the objectives. She felt compelled to cover the curriculum. She felt guilty that she was unable to cover all the topics in the seventh grade district

curriculum. She said that students would be expected to know this prior knowledge at the eighth grade and high school. She said,

> *If they don't have it in seventh grade, they might not be able to work on something else in eighth grade, to build on, prior knowledge kinds of things. So, if we do not cover it the kids might have a gap in what they know. And so it's important to try and cover it all and that is hard when you are using embedded assessment (MJ/interv2/p20/March 2000).*

Marian's struggle with the curriculum was partly due to the fact that she was a new comer in the middle school curriculum and was therefore not familiar with it. She was also aware that the eighth grade teachers expected her to prepare students for the MEAP (Michigan Educational Assessment Program) at 8th grade, so there were pressures from her colleagues in the school. Marian Jones seemed to be experiencing tensions as a result of her participation in this study. She was new and still trying to learn and interpret the district curriculum, she wanted to be accepted by the eighth grade teachers as a hard working colleague who fulfills her duty by teaching all that she was supposed to teach. At the same time, she wanted to help students understand science and she used embedded assessment to help her achieve that goal. However, this slowed her down and she realized that she was not able to cover everything. That made her feel guilty that she had not fulfilled her duty as a teacher. She struggled with these issues throughout the study. These were some of the issues Marian brought in the professional development meetings.

3. Coverage of content versus understanding of content

As discussed above Marian's goal was to help her students understand science. She realized that covering content did not necessarily mean understanding.

> *My challenge right now is to try to figure out how to get this information to kids so they understand it, but you have to do it in this time period. So you can always go back and re teach it and if 75% of the kids get it I just move on. Some of it is not realistic about just how much re teaching you need to do and so right now my challenge is something of balance. How to pick up the best things, the activities,*

to get to the point that they need to know or the key concept, or the key idea they need to know and may be a couple of lessons instead of a whole week (MJ/interv2/p20/ March 2000).

Marian was experiencing tensions of various forms:

- Focusing on understanding, given the time period, and she was aware that teaching for understanding using embedded assessment took longer time
- How much reteaching she could do; her strategy was if 75% of the kids understood then she would move on to the next topic
- How she could pick up the best teaching and assessment strategies for the particular concepts she was teaching
- How far to go in-depth

Marian was in her first year of teaching middle school science. Here, we see her having a dilemma of balancing content coverage and teaching for understanding. She seemed to believe that it was not possible to have both at the same time. Yet she wanted to accomplish both.

Marian was also struggling with balancing what she called "the grade versus the knowledge thing." In the second interview, she said:

I think strategies it has changed some of them, just because re thinking how much they know, or how much they retain, and knowing, and thinking about you know, assessments more...happened you know. Em, I ***think I am still trying to figure out how to balance the grade, versus the knowledge thing****, because that idea of you know we have to grade them,* ***but how much do we do for grades, and how much do we do for their action learning,*** *and what work do I keep track of, and what work don't I, you know, because you can't keep track of it all. Everything I give them, I can't keep track of it all, and I can't grade it all" (MJ/interv2p30/March 2000).*

From the above statement it seemed to me that Marian was seeing differences in grading and in doing assessments that would help with learning. She saw grading as one of

those requirements that teachers do to keep track or document learning not to influence it. Her dilemma was a pragmatic one.

As I have indicated above Marian felt very bad and a sense of guiltiness because of not covering the curriculum. At the same time, if she slowed down and concentrated on kids' understanding there was a feeling of satisfaction and pride. In her own words, she said,

> *I feel bad because they are going to need to know that information. I feel like I am supposed to do, and I feel like I didn't do my job. But at the same time, they really know the three units we have covered and so I feel good about that. It's sort of a balance. I don't know how guilty I feel and I feel proud of them for knowing what they know (MJ/ interv4/p22/May 2000).*

This further supported the assertion that Marian was feeling some tensions and as a first year middle school teacher, she did not know that the decision she made to teach some things well and not cover everything was the right one. She did not know how to deal with these tensions. It will be interesting to contrast Marian with my next teacher, Lisa who is a veteran with lots of experience. Do the teachers experience the same tensions and how do the deal with them?

b) Problems that relate to students

1. Attitudes of Marian's students

One of the problems that Marian described was the type of students that she had in most of her classes. She saw this as impeding her success in using embedded assessment. Marian reported that most of the students in her classes lacked curiosity and did not wonder about anything. For example, Marian asked them to write 3 questions they had about plants but they did not put much effort into thinking about it. She reported that they did the task so they can get done. Marian believed that in using embedded

assessment the student needs to be thinking all the time about what they are learning. Marian said, *" I am surprised at the lack of imagination, curiosity and a sense of wonder...when I was growing up, I think, I had more wonder about things. I wanted to ask questions about things.... I don't know what has stifled their wanting to know things" (MJ/interv4/ p28/May 2000).*

Another characteristic of Marian students relates to their attitudes. In her words, she reported that:

> *They write whatever it is they can get done quick, they regurgitate.....we are sitting in this class and don't say anything or don't ask anything. We won't have to do any work, we don't have to get into this lengthy discussion of anything... another thing is that quick factor, that you know we are not interested in this really and give us things that don't take too much time. We want to talk about so and so... They don't want to think and I am not sure why they don't want to think...they want me to give them the answer and instead of giving the answer I ask them another question (MJ/ interv5/p30/May 2000).*

These kinds of attitudes are not compatible with embedded assessment or with the teacher's goals of teaching for understanding. In embedded assessment kids have to talk and reveal their thinking so the teacher can monitor their reasoning. Marian realized that this was a problem in most of her classes but in the class that I observed 50% of students exhibited these forms of attitudes. Examples of things I wrote in my observation notes that support claims about students' attitudes are,

Marian said, 'I am not seeing serious thinking'...
Students seem to be very wild. A lot of conversations that do not have anything to do with what is happening in class. Some of her students seem not to want to learn but were interested in socializing. The challenge that this teacher is facing is behavior problems and getting stud3ents to be on task. It seems to me learning science is not that important for most of these students (FN/ March 14, 2000).

It was interesting for me, that when I looked for the evidence to support these claims, I only find such comments at the beginning of the project. This appears to support the

assertion that even though Marian was having problems with the attitudes of her students, these got better as Marian used more of embedded assessment.

2. Students' willingness to be taught "this way"

Marian reported that students have to be willing to be taught this way and not only that they have to buy into this 'new' way of learning. If they resist, it might be difficult for the teacher to continue doing this kind of teaching. Marian said,*" Another challenge is having kids buy into it, because I know in honors, there is a lot of kids that just want me to grade the paper and tell them what grade they got. Is it the right answer, or is it the wrong answer, black and white" (MJ/interv5/p39/May 2000).* Marian realized that in order to teach using embedded assessment, some cooperation from the students was necessary. My speculation is that students resist being taught this way because it is harder for them to think and show what they really know. It is easier to pick the answer and write exactly the same words. Marian alludes to this in interview 5:

> *I had some do reading, and then answering questions, and instead of reading and understanding it, like reading, and then thinking about it, they would answer the question by looking back in the book to where they found that bold face vocabulary or whatever it was, or idea, and then just wrote whatever was behind it, even if it did not make sense. My expectations is that they should read and understand but they are not reading for that, they are just reading to get the answers, having noticed that, I now design my own questions that do not directly deal with the text, as its said in the text, they will say it's too hard and the answer is not there" (MJ/ interv5/p14/May 2000).*

The students' capability of reading for understanding seemed to be problematic. Marian explained that they just wanted to copy the answer without even thinking about it or understanding it. The teacher said it was easier and quicker to just pick the answer. This way it does not involve any thinking. Marian noticed that her students wanted to finish and be the fastest without worrying about the quality of their work. My inference is

that students have learned how to do this in their seven years being in schools and in fact some have been successful even without understanding anything and learning anything. It is hard for the teacher to break this cycle and using embedded assessment will be a challenge in such a classroom. Marina's realization about her students responses (which means that she was analyzing their work) and the action she took to change the questions was compatible with embedded assessment.

3. **Kids resisted teaching for understanding: The "right answer syndrome"**

Marian was aware of some of the dynamics that were happening in her class. One of these was the 'right answer syndrome'. She said, *" They want you to give them the right answer. A lot of the times they just say, alright, Miss Jones just give me the right answer...I don't understand what you are saying and I do not want to understand it, just give the answer and I will get an 'A'. That is what they think when they come here" (MJ/interv5/p15/May 2000).*

I call this the "right answer syndrome" because I think schools have socialized students to have certain attitudes about what it means to teach and learn that are detrimental to understanding and learning. If you try something different like Marian you are sure to meet some resistance not only from the students but the system of schooling as a whole and I will discuss this later in the discussion chapter.

4. Skill deficient students

Marian discovered through the use of embedded assessment that students did not have the knowledge base and skills to be successful at learning and understanding the 7th

grade curriculum. Some examples of skills that Marian talked about include reading, writing and basic mathematical skills.

> *Those skills are not there and I am supposed to do all this stuff in the curriculum and they come to us with no background knowledge to be able to progress to the point where they are supposed to be at the end of seventh grade....embedded assessment will require me to start helping with reading, writing and mathematics but If I do that I will never get to the seventh grade curriculum and next year they have the MEAP and the 8th grade teachers assume I have covered the curriculum (MJ/Interv5/p35-36/May 2000).*

Once again, Marian was having a dilemma to help students with their deficient skills or to cover the 7th grade curriculum. I think this was a significant concern that Marian was raising here. She came up with her own strategy of how to deal with this problem. Her strategy was "I try and teach what I can or re teach some concepts and while learning the curriculum I help with some skills" (MJ/ interv5/ p37/*May 2000).* Marian negotiated what was possible and realistic to do given her context and the time she had.

5.Students need 'training' in various aspects

Marian saw a need to 'train' students in various aspects that included how to respond to assessment strategies with which they might not be familiar, including modeling questions and answers that demonstrate thinking, reading for understanding and writing to express your thoughts. She said,

> *How I started, let me remember. I.... I can't remember how, I think I just started with umm, discussions, and I think I, but I think I, but I think I really wanted the kids to talk to each other, ...just to try and get them to talk to each other and make comments to each other or, umm, I think that's what I tried. I started out with, and I think that that's really, it could be really successful, but they need a lot more training. That's one of the, that's one of that training thing. They need a lot more, what's an appropriate comment to make, what's, you know, feedback for another person (MJ/interv6/p27/June 2000).*

'Training' students in various aspects was problematic for Marian. She had already pointed out that teaching using embedded assessment slowed her down. She was aware that her students did not have the necessary skills and she had to spend some time helping them to improve their skills. Now, she had to train them not only with one aspect but in many aspects so they could participate in embedded assessment in appropriate ways. This became frustrating for Marian, as she was now well aware that she would not cover most of what she had planned in the beginning of the year.

c) Problems/struggles/tensions that relate to the teacher and teaching

1. Teaching and assessment strategies

Marian was not familiar with some of the teaching and assessment strategies that she learned as part of the study and therefore had trouble with teaching using those strategies. An example is peer review/editing. Marian had not done this before in her classroom and she needed more support to do peer review effectively. She explained this in interview 5:

> *I did not practice peer editing that much, and so I think I have the knowledge, but it was like trial and error and I think more support will help and more ideas about how to introduce it to the kids and to keep it going. I think that even though I have an idea, I do not think we use it a lot here...and I think also it would help to know about, just asking questions, prepare the teachers to model better ways of asking questions, you know better question posing, pose some better questions to get more information, and then having students pick on that modeling as well as maybe even some instruction about questioning, or gathering information, or what you do next (MJ/ interv5/p8&9/ May 2000).*

Marian realized her weaknesses but when these assessment strategies were discussed during the professional development meetings, Marian was confident that she would be able to do them. Therefore, we did not spend a lot of time and detail during the

professional development sessions talking about these. There was an assumption that teachers would be able to do these. Marian also reported that posing good questions was a challenge for her. This showed that Marian required 'new' or further polishing of skills to do embedded assessment effectively.

Marian was not only uncomfortable with some of the assessment strategies, she was also struggling with selecting appropriate teaching and assessment strategies. Her students' mood, their learning styles, and the context in which she was teaching are some of the things she mentioned as important to consider when selecting teaching/assessment strategies. She said, "*I think some of it is based on what the students are like, that day, that week, and also some students like to write, some like to draw, and some are oral, and you have to think about this when choosing your assessment strategies and this is a challenge" (MJ/interv 6/p21/ June 2000).*

Marian was mindful of the types of students she had in her classroom; she was ware that using drawing as an assessment, for some students who do not like drawing, might be an inaccurate assessment of what they really know, and therefore how to choose appropriate strategies for accurate assessment was challenging for her.

Related to that was the challenge of dealing with varying levels of understanding. In interview 4, Marian reported that: " *The practical side...not only of understanding what they are saying but the varying levels of understanding among students....how do I adjust my lesson tomorrow to address these" (MJ/interv3/p38/ April 2000)?*

Marian was seeing the complexity of doing embedded assessment in the classroom. This complexity made doing embedded assessment challenging for her. Not only was Marian noticing the practical challenges, she was also seeing that she needed

certain skills like analyzing and interpreting what students say, write or draw, and using the information she had analyzed in a constructive manner. She realized that to understand kids' thinking you have to be an analytical thinker yourself. Processing what students are saying or writing and putting that into a valuable lesson was hard for her. She said, "*It takes a lot more energy, a lot more planning to be able to take what they know, or notice what they are confused about and pull it apart and come back tomorrow, and do something that will address that" (MJ/interv6/p18/June 2000).*

Embedded assessment seemed to be demanding for Marian. It demanded certain skills and more time and the practical side of it made it even harder for Marian to enact it systematically in her classroom. Marian reported that she needed a lot of support to do this and my presence and conversations after the lessons were helpful for her to continue doing embedded assessment.

2. Teacher Models

Marian found our professional development meetings to be useful for her. In these meetings, the three teachers would talk about what they were doing in their classrooms that was associated with embedded assessment. Marian reported that, "*It was helpful to hear from other teachers who are focusing on what we are looking for specifically, but it would have been more useful to see someone live or on video doing this in a real classroom" (MJ/interv3/p46/April 2000).* Marian's challenge was that she had not seen anyone do embedded assessment with real kids and therefore she did not know what it looked like. She was constructing it as she went. She had no role models for using embedded assessment. She preferred teacher role models because they were more practical than abstract and were more believable. She said, "*I don't know what it looks*

like. We have these examples in the booklet but I am thinking, 'What can I do with these examples?' I am going to change some stuff" (MJ/interv2/p47/ March 2000)?

Another challenge that Marian faced was using embedded assessment systematically. She said, *" That's the hard part of making it, having it be conscious. Right now, I just have not had enough practice thinking about it and doing it" (MJ/interv2/p36/March 2000).*

The quotation below gives a good summary of the things she was struggling with:

> *How do you plan for it first and then how do you know it is going to work? Do you just try it and see if this assessment isn't good enough or if this is really working and then how will you go back then to say well, I need to do this differently, how else can I do this and how do I choose the next thing? What criterion do I use to choose what to do next? It's like It's too general, of like oh you can just assess these in different ways. If I could have specific examples that I may have and see the connections between planning and doing it, I guess" (MJ/interv2/p37/March 2000).*

Marian wanted very specific examples about how to use embedded assessment. In this study, we strategically did not do that because we wanted to study how she was making sense of it. My hunch is that, just like her students who complain about doing challenging tasks, it was harder for Marian to struggle with similar challenges. Also, teachers attend what might be termed ' recipe professional development', where they are given specific details on what to do. Yet in this project, we were requiring teachers like Marian to make sense of it and I acknowledge that this is harder. It requires teachers to put more thought into what they are doing and back it up with logical reasoning. But maybe this was too much to ask of a new teacher.

3. Marian was overloaded, overwhelmed and frustrated when we began staff development and classroom observations

During the first two weeks of the study, Marian felt so overwhelmed that she requested that I slow down the pace.

" I felt overwhelmed because of all these things I had to do in my class and the after school meetings leave no space for one to breathe and added to this are all the other things I need to do, plus the fact that I am new and trying to learn the system" (MJ/interv2/p10/March 2000).

Marian was overwhelmed by the expectations for this project. For example, in the first two weeks she had to come to after school professional development meetings plus two after school interviews. At this time the teacher had to prepare for her classes and it was also the marking period and at the same time she was planning a field trip. Right then as a researcher, I realized that I had to set realistic goals and keep her excited about doing embedded assessment. Marian was also frustrated about the lack of basic skills by students (as discussed above). In one instance, she had to teach mathematical skills, which used up even more time in getting to teach science.

"...It was basically multiplication and division. They had no idea which one they divide by. It was just the math skills were lower. So, I could not do what I needed to do. I really needed to re-teach the math to be able to do what I needed to do, so that took me longer to do. It was frustrating to me" (MJ/interv5/p12/ May 2000).

Frustrations often are indicators that something significant is going on. In the case of Marian, I think she simply had too much on her plate and she could not handle it and that led to frustration. But this would be common for most teachers: staff meetings,

district meetings, pacing guides, MEAP tests, new curricula etc. but it would be especially hard for a beginning teacher.

Problems that relate to parents

Another problem that Marian talked about was the accountability to parents. She believed that it was hard for parents not to focus on the grade, because that was the kind of education they experienced. She reported that most parents in her school are not in touch with new reform ideas in education. Marian believed that grades are important to parents as well as administrators. Marian believed that most parents in her school did not know anything about embedded assessment. She felt that they needed to be educated about ideas like embedded assessment so they could understand what their kids are doing in school and support it. She reported that most of her students came from very poor home backgrounds where parents did not have the time to support their child's education.

Analytical Summary of the Marian Jones Case

Marian Jones was in her second year of teaching and first year of teaching middle school science. She was working in a school with many poor and minority students. She had chosen to teach in an area where she could make a difference. She had been through a teacher preparation program that engaged her in students' thinking and saw this project as tool that helped her pursue the goals and ideas she learned in her teacher preparation program. Marian passed through three phases in this project. The phases began with a feeling that she understood embedded assessment; then doubt and questions set in, and finally she felt confident that she could do it. The professional development meetings were a support system that enabled Marian to continue using embedded assessment despite the challenges. My classroom visitations were also helpful in supporting and

encouraging her. Marian reported that she had learned a lot of teaching and assessment strategies through this project. She believed that this project scaffolded her teaching in ways that could not have otherwise happened. It helped her redesign and adapt curriculum. In teaching, it helped her focus on students' ideas and use those in her lessons. In assessment, this project gave her a repertoire of tools for meeting the goals she already had with her students. In some ways, it actually gave her a way to see that this is the way she could find out what her students knew and did not know. It gave evidence about her kids' learning and it further convinced her that this was an important part of her teaching. However, this was not smooth sailing for Marian. It was filled with problems, tensions and struggles. I will now turn to my second case, the study of Lisa Leslie.

CHAPTER FIVE: CASE TWO

CASE STUDY OF LISA LESLIE

In this chapter I present the case study for Lisa Leslie. I begin by introducing Lisa Leslie, and then I present her views about goals and roles, students, teaching, assessment, planning and reflection prior learning about embedded assessment. In the process of discussing her views about teaching, I also provide a brief example of her practice. I then provide the journey of Lisa Leslie in the embedded assessment project.

Introducing Lisa Leslie

Who is Lisa Leslie?

Ms. Lisa Leslie is a woman in her late 30s. She was born in New York City and was raised in Lansing. As a student in high school, she was placed with students who were considered slower and "at risk." One teacher made a difference in her life. It was a science teacher who conducted an experimental class for those students who weren't academically successful. The class was activity based and she commented,

> *...For students who were generally considered slower kids. It was fun, I learned a lot about how to do experiments and what to look for and the other kids learned a lot but they could not do the bookwork that went with it. I mean they could do all the activities but they could not take a test and from this experience I realized how important learning was than just passing a test! A lot of kids can pass the test but have no idea of what we are talking about (LL/interv1 p2/ march10, 2000).*

Early in her life, Lisa was aware that passing a test is different from learning and knowing, and that methods of assessing might not indicate what students really know. From her own experience, Ms Leslie was aware of this situation and hence her emphasis on learning over passing the test.

She obtained her undergraduate and graduate degrees at a large mid western university. She originally wanted to be a psychologist but realized that there were very few jobs in that field. So, she decided to major in social studies with a minor in science. The job she got was in seventh grade science. Once she started teaching science, she discovered that she loved it more than teaching social studies. She realized that she needed more science content knowledge and therefore she started taking masters level courses geared towards learning science. She did this through the College of natural science at a large midwestern college.

Ms Leslie believed that her teacher preparation courses were "useless" except for the internship year. She claimed that this was because they did not teach her what she needed to become a teacher. She reported that her collaborating teacher had a profound influence on her even up to this day. Her internship collaborating teacher teaches eighth grade science and is still her mentor (eight years after completing her teacher certification program). She reported that her internship mentor teacher taught her more about classroom management and asking questions to diagnose understanding than her teacher education professors. An example of what her mentor teacher taught is given below:

> *At first, students' answers meant nothing to me, but a kid would write 3 or 4 words and consider that an answer to a question. I would say to my mentor teacher, I don't know if this kid understands it; and she will say, 'ask them questions next day after you grade this, and see what were you asking, what were you explaining because it might be lack of writing skills and not lack of knowledge (LL/ Int1/ p5/March 10, 2000).*

This, in a way, is linked to embedded assessment in that it focuses on asking questions to see what students really know. Before participating in the project, Ms Leslie had experience and coaching in focusing on what students know, which is a key component of embedded assessment. Her conversation with her mentor also indicated

that teachers should examine closely what students write because there might be something more in their writing that could be probed by the teacher. This appears to be related to the debate of whether tests are good indicators of what students really know. This research study, with which Lisa was involved, pushed for the use of assessment as a major and integral part of teaching and learning.

Ms Leslie has been teaching for seven years. Before her current job, she was a substitute teacher for one year. Ms Leslie volunteered to participate in this project because she thought that embedded assessment was a valid tool to use as a teacher. But she felt she was weak in the area of embedded assessment and hoped that participating in this project would encourage her to use embedded assessment often. She was interested in knowing how to use embedded assessment to enhance her teaching. Next, I turn to look more closely at her views on various aspects before she learned embedded assessment.

A portrait of her views on goals & roles, students, teaching assessment, planning and reflection before Embedded Assessment Project

Goals and Roles

One of Ms. Leslie's goals this year was to help students to have "*good enough understanding of the concepts so they can build on them in 8th grade and high school and also so that when they see it happen out in the real world, they recognize they learned it*" *(LL interv1 p13 March 2000).* Ms. Leslie saw her role as that of a facilitator of learning and sometimes (depending on the task) she saw her role as "director" of learning. She loved being in charge, for example, she said,

...that really depends on the lesson. I know that my answer is supposed to be a facilitator of their education, and sometimes I am and sometimes I am a director of their education..... Sometimes they are little soldiers, they have to pay attention and do what I said and sometimes, they have to make inferences and conclusions all by themselves. My students actually prefer that I am always in charge" (LL/interv1/p12/March 2000).

Based on my observations for a week before interview number one, Ms Leslie was in total control of what happened in the classroom. In my March 8th observation notes, Ms. Leslie explained what the words like 'niche' meant and the students sat and listened and took some notes. Occasionally, the students would answer a yes or no question but nothing that asked them to elaborate their thinking. Furthermore, the notion of being a director might imply a teacher centered classroom and this might be due to classroom management issues. When teachers like Ms Leslie give their students more choices, they tend to think that there will be no order in the classroom. This might have negative connotations as the teacher sees herself as failing to manage her classroom. One thing I noticed from being a participant observer in Lisa Leslie's classroom is that Lisa wanted total order in her classroom. If the teacher is in total control of what happens in the classroom, this may mean that students do not actually do a lot in terms of thinking and participating actively. However, both the teacher and student might prefer this because it does not require much from them. As we shall see, Ms. Leslie's conceptions of her roles and goals changed after her work with the embedded assessment Project. The next section will continue the description with her views about her students.

Teacher's views about students in her classes

Lisa believed that you could not help all of your students because there are so many bad things in their life that impinge on their success at school. She said,

> *School does not mean anything to them, and I do not mean anything to them and I* ***never*** *will. Some of them have parents that do not treat them right and do not have enough money to support them. Mom and dad have been in and out of jail, or dad beats mom, or mom and dad do drugs, and deadbeat alcoholics. All sort of things that affect what the child is thinking about instead of school (LL/interv1/p20/March 2000).*

In this quotation, it appears Lisa was dealing with her own feelings about her students' background. She was confronting societal issues and how she encountered and dealt with them at the classroom level. She seemed sympathetic about some of her students' backgrounds and at the same time, she argued that the home background issues affected the child's thinking in ways that rendered school less important to think about. This gives a profile of some of Lisa's students.

As a way of motivating her students, Ms Leslie hangs the best work around the room and in the display case out in the hall. She encouraged students to compare their work with what the teacher considered was the best. She believed that this would help both the 'slow and fast learners'. It gave 'fast learners' a little push, and provided exemplary work for 'slow learners'. She used a rubric specific to the assignment that described the criteria for best work. We will later see how her use of students' work changed after she learned about embedded assessment. Next, I discuss her views about teaching.

The context

Lisa taught six seventh grade science classes. For the purposes of this project I observed only one class. Lisa's 6th hour class is composed of 28 students. 15 of the students are black, 5 are white, five are Asians, and 3 are Hispanics. Of the 28 students in this class 14 of them are female. Lisa's classroom is decorated with a map of the world, human skeleton diagram, a chart showing Michigan forests, and several samples of students' work

displayed around the class. Lisa has a television, overhead projector, computer and printer in her classroom. She had one-hour periods for each lesson. During my observations, I noticed that each time I visited, at least two or three students were absent from school.

Teacher's views on teaching

Ms. Leslie's view of effective strategies for science teaching was that science should be activity-based with a lot of labs and concrete experiences for students. She believed that good science teaching should focus on understanding. Lisa believed that teaching for understanding has to do with the application of knowledge to real life situations and the students must be able to connect concepts. She said, "*If they spit back the facts to me and tell me where it is used ... that's understanding. If they can take the knowledge and apply it to a real life situation, then they understand it. If they spit the facts to me, it is not understanding" (LL/interv1/ p/data3/March10, 2000).* At first, I thought that Ms Leslie's view to push for understanding rather than the regurgitation or recitation of facts would provide this project a good starting point in working with her. But we will discover later that this was just 'talking the education talk' and not 'walking the walk'. In interview number one, she said that she handled concepts that were not completely understood by discussing what they have already covered and she addressed misconceptions by leading a step-by-step discussion of concepts. (LL/interv1/p11/March 2000).

Ms. Leslie recognized that as she taught, students were processing the information in their heads and this processing differed student by student. This results in different levels of understanding of each topic taught. She believed that not all students will " get it," so there is a time when you just move on. She said, " *As I taught science classes, I noticed that there are students who get it in a more in-depth way, and there are some that are close to getting*

it, and some that do not get it, but do they always all get it? No" (LL/interv1/p11/March 2000). This was an insightful comment from her because I think that often educators assume that students come with the same level of knowledge and that they will reach the desired levels after instruction. Ms Leslie believed that most teachers do not have the tools to help them address different levels of understanding. Embedded assessment is a tool that can be used to diagnose these levels so the students can get help to attain the desired level of understanding.

Ms. Leslie enjoyed teaching 7th grade science because her lessons were activity based and not focused on the book. She believed that this made her lessons interesting and not boring for the student.

> *Science is activity based not just bookwork that kids do day after day. It's never boring. I hate being bored. You can talk to the kids and rationalize.... Although some times they are irrational because they are seventh graders, but you can talk in-depth to them instead of just memorize these facts.... Talking in depth means you pose scenarios that help them understand concepts (LL/intervi/p2/March 2000).*

This quotation helps to clarify the teacher's stance on teaching seventh grade science. I summarize the points below:

- Activity based
- Not focused on book work
- Not boring
- Talking in depth to students so they can have a deep understanding

It is important to understand this stance before she learned about embedded assessment, so that we can clearly see any changes or the impact of embedded assessment on her teaching. The following is a short description of one lesson that demonstrates what

Lisa's classroom looked like before embedded assessment. I will contrast it with her viewpoints in interview number one.

An example of Lisa's teaching before embedded assessment

Lisa wrote the objective of the lesson on the board, 'To review vocabulary words relating to the ecosystems.' Students were seated in rows, and had to use worksheets to fill in the words. They were to use their textbooks. After students were done with their worksheets, there was a class discussion. Below are excerpts from my notes.

Lisa: *Do you remember what a biosphere is?*
Student: *No*
Lisa: *All organisms live at or near the earth's surface in a life-supporting zone called The biosphere* (notice that Lisa answered her own question)
Lisa: *How would a biosphere be different from a community?*
Students: Silence
Lisa: How many people think there is a difference? (12 students raise their hands)
Lisa: What does interacting mean? If I am a bird and I put my nest in a tree, are we interacting?
Student: Yes
Lisa: Specific groups of animals or plants living together right!
Lisa: What does dominant mean?
Student: Something that is stronger
Lisa: What does mutualism mean?
Students: Silence
Lisa: Look in your textbook.
Student: It does not make sense (FN/p4/ February 2000)[1].

In my conversation with Lisa after this class was over, she indicated that students did not know the vocabulary, even though they had been learning about ecosystems for a good amount of time.

In analyzing the class discussion, I noticed that the teacher dominated the talk and even answered her own questions. Students had very little to say. She seemed to want definitions like the ones given in the textbook. There were few instances that indicated that Lisa was interested in how her students were thinking about those definitions and whether

they really understood what the definitions meant. Lisa was the center of everything happening in the classroom, in the typical Interrogate-Respond and Evaluate format that dominates traditional teaching. This way of teaching was a consistent pattern in most of her classroom discussions.

Analytic commentary about Lisa's views on teaching and her observed practice

From the discussion above about her views on teaching, there were places where it looked like she would have an easy time with embedded assessment. Her views about teaching for understanding and application of knowledge to real life situations and giving kids a concrete experience are compatible with embedded assessment. She claimed that she did not push for recitation of facts. But when we look at the excerpt of her lesson described above, it seemed that her lesson was focused on book definitions and not focusing on helping kids connect ideas. From the first interview, it looked as if Lisa was going to be a success story, but we will later see what unfolded in her journey of embedded assessment. Before we do that I will discuss her views about assessment and her assessment practices before embedded assessment.

Teacher's views on assessment

In Lisa's district there were district wide unit tests that were constructed by teachers. [2]Lisa was involved in the construction of these tests and therefore she had a sense of ownership. The teacher believed these district wide assessments were a valid form of assessment. She said,

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[1] FN denotes field notes, p4 is page 4 and the date for the observation

I do use the school district unit assessments. I think it's a valid assessment, probably the most important pieces of assessment, and it is not going to go away, but not all my students are good test takers and the district tests are about ideas and concepts and not about facts- you have to take the things that we've learned and be able to transfer (LL/interv1/ p7/ /March10, 2000).

This teacher strongly believed in district wide unit tests. But she was concerned that students had a problem with test taking techniques, which consequently influenced their performance. She also reported that questioning is as much of an assessment as a test.

Teacher's views on embedded assessment

Lisa believed that everything she did in her classroom was a form of assessment. In her own words she said, "***Everything I do is an assessment***... *it tells me this kid did not do the work, ...this kid is lost, this kid is good at worksheets but they do not really understand the concepts...*" *(LL/ interv1 p7/March 10, 2000).* From her comments, we can see that she partly understood embedded assessment, but did not mention relating the information she obtained from students to her teaching. She understood that every activity she did in the classroom was an opportunity to assess her students' understanding of scientific concepts. Adjusting instruction was the missing piece. As has been discussed on the section above about students, Lisa chose exemplary students' work to display so other students can compare and contrast. She did not mention anything about linking information on students' understanding to her practice. I thought that her disposition to see everything she did as a form of assessment would provide a good start in working with her. But as we will see later it was not so.

What kind of assessments did Lisa give before embedded assessment?[3] We have seen in the section about teaching the kind of questions she asked. Basically there were no thinking questions and most of her questions required yes or no answers. She also gave worksheets that were composed of the "check your vocabulary type" of task, for example, ' *a group of the same species living in a particular area is a ----------,' the variety of organisms that live in an environment is called---------,' ' What is the name given to an area in which organisms interact" (FN/ p4/March 2000)?* Students had to write one-word answers. She commented that she liked to use worksheets because they are easy to grade and they do not take much time for her.

Analytical commentary about assessment

In the discussion of her views about teaching, Lisa stated that if her students spit back facts to her that was not understanding. But the kinds of assessment that Lisa was giving (like the ones just described above) required students to do just that. It required them to give back the facts and not expose their thinking or understandings. Lisa said she liked the district tests because there were about ideas and connecting them. But in her own assessment tasks, I did not see her pushing such kind of assessments (district). When she talked about the district tests and her involvement in them, I thought she would have a fairly easy time with embedded assessment. But we will see later that she did not have an easy time with the embedded assessment project.

Planning and Reflection

In this section, I discuss how Lisa planned and reflected about her teaching before she learned anything about embedded assessment. She described her planning as follows, "*I*

[3] I do not have the actual worksheets but I will give a description based on my field notes

usually pick an objective out of the Lansing school district, then find activities that show that objective, and I pretty much plan on a daily basis, and after giving a test, and I find that there are some things my students do not understand, I go back and review the concepts" (LL/interv1/p11/March 2000). The typical planning process for most teachers is weekly/monthly or yearly. But Lisa's planning process was a little different from a typical seventh grade teacher in that she planned daily. Other teachers might plan for the whole year/week/monthly and maintain their plans regardless of how their students respond to their plans. Ms Leslie planned for the year and reflected and changed her plans daily based on what happened in her classroom. Planning daily shows that she considered how her students would react to her lessons. It appears that Lisa's stance on planning was compatible with the cyclical, ongoing nature of embedded assessment. The idea of visiting concepts that students did not understand after the test shows that in her daily planning she did not consider revisiting concepts that were not completely understood. Ms. Leslie reported that most of her reflection occurred during the summer. She said, "*I usually reflect during the summer, finding things that I would like to add to the unit, changing things, lessons to drop because they did not work--- I don't spend my time kicking myself about things that did not work"(MV/interv1/ category 7/data 3/March10, 2000).*

This may be typical of most teachers, but unfortunately reserving her reflections for the summer means that they were too late to help students in her class. We will examine later how this view changed after embedded assessment.

Analytical commentary summary about Lisa Leslie's views and practice before embedded assessment

The features of embedded assessment that we hoped teachers would use were:

- cyclical
- Ongoing
- Involves teachers gathering data about students' understanding or lack of it
- Involves analyzing and interpreting students' work
- Occurs at the same time as teaching and not after teaching is over
- Includes timely adjustments in teaching, based on students' ideas and reasoning about scientific concepts
- Focuses on students' difficulties and uses student work for deciding next instructional strategies

In the section below, I discuss where I see Lisa in relation to the framework of embedded assessment. The purpose is not to evaluate Ms. Leslie' knowledge about embedded assessment but to clarify the impacts of this tool (embedded assessment) and conclusions that will be made about her case.

So, what do we know about Lisa at the beginning of this project? Ms Leslie is an experienced teacher who seemed to have a compatible stance with the ideas about embedded assessment. She seemed to have the cyclical and ongoing features of embedded assessment in her planning because she did this on a daily basis. She stated that she saw everything she did as a form of assessment. This to me highlights the blurring of the assessment and teaching features of embedded assessment. She had a partial understanding of embedded assessment because she seemed to be using some aspects of embedded assessment. Yet, it was hard for me to see the embedded assessment piece in her practice. Her beliefs about assessment and good science teaching were a good starting point for continued progress in embedded assessment. However, her views about her students, her

roles and her students' roles seem to present challenging notions for implementing embedded assessment. It will be interesting to see how she changed or not at all in this project. Now I turn to describing the journey of Lisa Leslie in the embedded assessment project.

Lisa Leslie's journey in the embedded assessment Project

The section that follows addresses my research questions: how Lisa Leslie makes sense of the idea of embedded assessment, how embedded assessment looks in her classroom, and a brief account of what her problems were. It will give a story about the journey through embedded assessment for Lisa Leslie. My data analysis shows an emergence of three phases that Lisa passed through in this project. The section that follows will discuss the three phases by using data from three different sources, i.e., professional development sessions, interviews, and observation notes.

Assertion # 1 Lisa Leslie passed through three phases in her involvement with the embedded assessment project

Before I discuss the four phases that Lisa passed through, I will first expand on the context with the following questions in mind. What happened in the professional development meetings? What was Lisa's experience in the professional development meetings? How did Lisa participate? As we have seen in the methods chapter, the embedded assessment project had four professional development sessions done throughout the study. The agenda for this professional development was co-constructed by the researchers and the teachers.

The purpose of the first meeting was to introduce the teachers to the idea of embedded assessment. In this meeting Lisa was very vocal and her stance on embedded assessment was clear. She liked the idea of embedded assessment but questioned whether it was possible to do in the school setting. In the second professional development, Lisa did not bring any of her students' work, although this was required for that meeting. In the third professional development meeting, Lisa talked a lot about what she did in her classroom and the things she was learning as a result of using embedded assessment. In the fourth professional development meeting, Lisa was reflecting on her experience in this project and the things she was taking from this project that she was going to do the following school year. Lisa was an active participant in all the meetings. In the next section, I will provide the phases of Lisa's journey through embedded assessment. I will first discuss Lisa's reactions in the professional development meetings and what she said in the interviews and what was happening in her classroom at each phase. Then I will discuss the kind of problems she was alluding to at each phase. I will conclude each phase by comparing all the three sources of data for Lisa Leslie.

Phase #1 Lisa partially rejected the theory of embedded assessment and questioned its feasibility in the school system

During the first professional development meeting we had with the three teachers in this study, Lisa was very vocal and expressed what she thought about what was being discussed in the meeting. She partially rejected the logistics of doing embedded assessment, by saying,

> *The time frame, the logistics of doing some of the things is* ***next to impossible*** *when you are actually teaching four or five classes a day. Finding misconceptions that*

kids have, who has what misconception, or what the primary misconceptions are, making sure that you hit every kid's misconception. It does work when you talk about it, and you get the idea of the main misconceptions that the kids have and you address those. But if I have 28 kids in three different classes, I could easily end up with 50 different misconceptions and yet there might be ten of them that everybody has (PD/#1/p4/February 2000).[4]

Lisa was questioning the practical side of doing embedded assessment. She saw it as practically impossible given the conditions under which teachers work. She pointed to the number of students she had and the possibility that each might have misconceptions as a limiting factor in doing embedded assessment in her classroom. She believed that it was practically 'impossible' for her to address all of their misconceptions. However, she believed that it might be possible to address the misconceptions they have in common. So, while she believed that it was important to know about and address students' misconceptions, she felt this was logistically impossible in her situation. The facilitator (a science educator) gave some ideas about strategies a teacher can use to handle her concerns, for example, peer review. But Lisa saw this as problematic for students who have not tried this strategy before. At that time, she did not believe that students should grade each other's work.

Lisa struggled with the idea of giving feedback only without grades. Assessment to her also meant that she had to periodically give grades. She responded to the idea of not giving grades by saying,

Our job is to assess how well they know the information and give them a grade and yet when I took my college courses, they talked about well the grade isn't the important thing. To people in their dream world maybe, but down here in the trenches, to me, my kids and their parents, the principal and the school district, grades are ***very important****. School is about giving grades and not the other side.*

[4] (PD/#1/p4/february 2000 denotes this was not an interview but a professional development session. This was the first professional development meeting and the page in the transcript is 4 and it was done in February of 2000.

school is about productivity, and it truly is, although you talk about higher goals aspects, it is not realistic (LL/pp1/p8/February 2000).

Lisa saw embedded assessment ideas as unrealistic, given what the district, principal and parents demand from her. So, what was Lisa doing in her practice at this phase? Lisa was continuing her teaching the same way as described before in the teaching section before embedded assessment. However, one thing that she was doing was giving feedback to her students plus the grade. What kind of feedback did she give? She gave feed back that required students to go back and read the textbook, so they can get the main concepts

Analytical commentary on phase one.

Lisa has been in the system of schooling for many years, including her years as a student and a teacher. She has deeply ingrained beliefs about how schools should be. Although Lisa did not completely embrace embedded assessment ideas, she was willing to try them out in her classroom. At this point Lisa was not doing any embedded assessment in her planning and teaching, except directing students to the book. When looking at Lisa's comments in the professional development meetings and in the interviews, then at her practice, all the data is consistent with the rejection of the logistics of embedded assessment. Therefore, Lisa was not doing any embedded assessment in her practice. I will now turn to phase two of the project.

Phase # 2 Complaining Stage

Lisa tried some embedded assessment ideas in her classroom. For example, she planned that her students were going to learn about the concept that all ecosystems have living, nonliving, visible and invisible components that interacted in a number of ways. She asked her students to observe an aquarium and then in groups of two to four students combined their lists. They were asked to draw the aquarium and show all visible and

invisible components. Students were to show possible relationships between living components such as predator-prey, producer-consumer, food chains, mutualism, commensalism, parasite-host, decomposers and scavengers.

Then students answered these questions:

- *What do you mean when you say a thing is living or non-living?*
- *What could be some of the characteristics of things that are invisible in the aquarium?*
- *Are the living and non-living things in the aquarium that are invisible important? Give a reason for your answer.*
- *How many relationships can your group find between different components in the aquarium?*
- *Group the components of the aquarium in at least two different ways (FN/p35/ April 2000).*

Lisa got the student responses from their groups. She analyzed them and found that students left out some critical components, such as carbon dioxide and oxygen, and all the relationships. She reported that some of the responses had naive conceptions. Lisa then strategized to address those misconceptions. In this assignment, students answered in groups. Lisa complained that the theory of embedded assessment is fantastic but in practice it did not work. (LL/inter2/p7/March 2000) Why did she think it was not working? Mainly because she believed that it is hard for teachers and it took a lot of their time and extra effort. Lisa reported that,

> *Worksheets with a right or wrong answer are easy. So, if I am doing a fill in the blank, I am done very quickly. If I am doing something that requires a written response, the response can be worded in twenty different ways or hundred different ways. So, you have to read them carefully, and you have to write back responses very carefully, so they understand what they got wrong, That takes a lot of time especially in my case, I have five classes with twenty five to thirty kids. It will be days before I get anything back to them (LL/interv3/p28/March 2000).*

Lisa questioned her ability to do this well and in a timely fashion. Her concerns were legitimate because the feedback might lose its relevance if it is given after a long time after students have written the assignment. They might have even forgotten what they did. It

might be too late to effectively address students' naive conceptions. It will be better to address these when kids are still excited about the topic. After trying the teaching/ assessment activity, Lisa was complaining about problems that relate to school and work conditions.

Tensions that relate to embedded assessment and teacher's working conditions

Lisa believed that the idea of embedded assessment is great and that is why she volunteered to participate in the study. She valued the idea of finding kids' ideas and using those ideas to structure her lessons. But she was very much concerned about the practical side. She believed that certain things have to change about how school is done, for embedded assessment to be implemented effectively. One example she talked about was what she called the 'time factor'. She said, *"The frustration with embedded assessment was just the time factor. It was extremely time consuming to do this correctly but I do not have the time"(LL/interv5/p28/May 2000).* Lisa reported that her major obstacle was time. This led to teacher frustration and burnout. She felt overwhelmed because embedded assessment required a lot more from her. For example, in addition to giving a lot of thought to what she was doing and analyzing students' work, she had to come after school for professional development meetings. Lisa had already some other responsibilities, for example, she was the head of the science department and involved in district initiatives. Adding one more thing with expectations for after school meetings created more stress for her. She believed that in order for embedded assessment to be effectively done, changes needed to occur in work load, number of students in the class, and other conditions in which teachers work.

Lisa was struggling with the idea of embedded assessment. In professional development session number 3, she said,

> *The implementation of this project was problematic because I know what to do, good idea...but how to do it, I just do not have the time to do it, to actually sit down and plan embedded assessment at all times during my lesson...pick up misconceptions, changing the child's thinking will be time consuming whereas I might, when I am first learning it like right now, it is taking me hours every night but I think once I get the hang of it will probably be easier and faster. Although I can see how it improves children's understanding, it just seems overload (p1/April2000).*

When Lisa said, '*I know what to do,* ' she was acknowledging that she understood embedded assessment principles, but was not sure about how to use it, given other factors that influence how schooling is done. Lisa had awareness that embedded assessment improved her students' understanding of scientific concepts. She found herself caught in the system in which she has to choose what will be best for her and her students. She used the 'give or take' analogy to talk about this,

> *It is a give or take .....That is a good thing that kids understand the concepts. It is a bad thing that we cannot finish the curriculum...there are reasons why the district put certain units in the 7th grade curriculum. One reason being that they have to know this stuff to help them with eighth grade science. But if we do not teach for deep understanding, whatever misconceptions they have in their head, we have never changed that concept because we did not go deep enough and the kids will just put down answers that we want to hear, but their thoughts on it are still the same and this makes me feel like I am wasting my time and their time. But in order to teach everything, I am still kind of stuck. (LL/interv4/p38/April 2000.*

Here, Lisa articulated the tension between teaching for understanding and covering the district curriculum. At this point, Lisa thought that you couldn't have both at the same time, because if you concentrate on using embedded assessment as a tool to help you teach for understanding, you will slow down the pace of covering the curriculum. In interview # 4, when I asked Lisa how embedded assessment was impacting her teaching, she replied, "*It has made me slow down the pace of the units, so as to go in-depth so kids can understand*

the concepts' (LL/interv6/p37/June 2000). Lisa was weighing two of her responsibilities as a teacher, pursuing understanding as a goal, while completing the district curriculum. If she did not cover the curriculum, she felt 'guilty' for 'not doing her job'. If she did not focus on understanding, she felt that she was wasting her time because kids were not learning much. They would be just giving back what they thought the teacher needed.

At the end of the study, Lisa resolved this tension by deciding to, *"use embedded assessment for difficult concepts only"(LL/interv6/p12/June 2000)*

When I asked how she would know the difficult concepts, she replied that she would use her wisdom from seven years of experience and from talking with other seventh grade science teachers.[5] In response to these tensions, Lisa created new practices that reflect compromises in the cyclical nature of embedded assessment. This new way of teaching was not envisioned in the original conception of embedded assessment. This is what I refer to as Lisa's 'compromised and interpreted' conception of embedded assessment.

Analytical commentary for Phase # 2

We have seen that Lisa's teaching in the second example involved students more in the lessons. They were required to come up with a product of their own. This is different from the lesson I described earlier on before Lisa learned embedded assessment. The questions that she asked required more elaborate answers. Lisa did not see this as advantageous; instead she saw as a lot of work for the teacher. This caused Lisa to complain about other factors that made this hard. As a result of all this complaining, Lisa was not very willing to give her students such kind of questions. She reverted to using her worksheets because they were manageable and easy to use for her. Some of Lisa's concerns included

6 I also referred her to a book by Rosalind Driver on common misconceptions in secondary science. I also referred her to a book by Rosalind Driver on common misconceptions in secondary science.

the fact that there were too many kids in one class for her to be able to do embedded assessment effectively. She did not have time to do embedded assessment and enough time to plan and reflect well. She already had a busy schedule and this project was requiring a lot from her at this point. She was feeling overwhelmed and overworked. There are other concerns that arise for Lisa, and I will discuss them in the phases that follow. But in this section, I wanted to provide a brief indication of the obstacles she was already encountering. Overall, the complaining was based on these two key issues: she did not believe that the embedded assessment project was practical and secondly she recognized all the above contextual obstacles. Given these concerns and obstacles, what happens next is remarkable: Lisa had a breakthrough in her classroom. In the following section, I describe Lisa's turning point in the project.

Phase # 3 Lisa had an 'aha' experience which marked a turning point

During one of my classroom visits, I had a chance to sit down and talk to Lisa. I encouraged her to change her questions and use of worksheets. I told her we wanted to see how individual kids would respond to such kind of questions, because earlier on we had seen their responses in a group. We actually started with what she called her 'best' class. She gave them two open-ended questions, e.g. "Tell me what you know about plants and how do they obtain food"? Lisa was really surprised at her kids' responses to these questions. First, she discovered that their writing skills were so poor that she needed to stop her plans and concentrate on helping them write and state their ideas clearly. She talked about this later,

You started realizing that what you thought they knew and what you thought they learned, they might have just been guessing. They might not have really learned it, that it was reading something and recognizing a word in the answer that made them choose that. But if you use embedded assessment accurately, you need to see them write something that comes

from their own knowledge, from their own internal idea and so you use open-ended responses rather than multiple choices or fill in blanks. The results are so vastly different, such that I did not know if they learned anything the entire school year, because that is what I used most of the time. This was very depressing for me and I stopped because I could not handle the thought of wasting my time and kids' time all these years they have sat in my classroom (LL/interv4/p43/ April 2000).

Lisa was now seeing possibilities instead of impossibilities. She was seeing ways to learn about her students' ideas and to help them with how to state those ideas clearly and accurately. She saw the differences in using different questions or assessment tools. She discovered that the worksheets were deceiving to her as well as to students. They did not show kids' thinking, ideas and confusions. The teacher deceived herself in thinking that they understood the concepts she was teaching, not realizing that they might be just putting words on paper.

In addition, the open-ended questions revealed that her students did not really understand some of the concepts that she was teaching. This evidence from her own classroom had a powerful impact on Lisa, as I discuss in the next section.

Lisa showed a positive attitude and willingness to systematically use embedded assessment

Lisa described what she did next:

> *I took what they did Thursday out of each class, I copied six or seven representative examples of their conclusions which were bad, and I had one decent one out of the entire team of students, and copied down their conclusions and then handed all their papers back. We had a class discussion about those seven conclusions after they had an opportunity to talk about it in smaller groups, and I asked them to examine why they are wrong or incomplete. The conclusions were not specific; they did not show any evidence with reference to the data, nothing. I told them, you and your team, you have 15 minutes to analyze the seven conclusions and make complete conclusions (LL/interv6/p39/June 2000).*

Lisa showed a 'new' desire to try out embedded assessment in her classroom. She also realized that when she used different teaching strategies, students seemed to really 'get it'. Her willingness to try out embedded assessment set a new atmosphere in her classroom.

A three-day teaching sequence using embedded assessment

Next, I describe a three-day sequence of lessons in which Lisa used embedded assessment. I chose to provide a 3-day sequence so the post embedded assessment adjustments could become visible.

Day one

Students were given a paper and asked to design, draw and color an ecosystem. The seating arrangement was changed. Students were now sitting in groups facing each other and were no longer in rows. The guidelines given had questions that students were supposed to answer after they had drawn their ecosystem. The questions given were different from the types of questions she gave earlier on, in that they required students to think and come up with original answers that applied what they had learned. The questions were not one-word answers but required elaborate answers. Students did not finish this task and were given some time during the transition period to do that.

Analytical commentary

Why is this embedded assessment? I claim that this is embedded assessment because the teacher gave an opportunity for students to show what they know. So, this was a way for

the teacher to gather information about what students know, what they do not know, and where they are confused so the teacher can use that information.

Day Two

Students were expected to work with two groups. Each group had to share their poster with another group. The groups exchanged posters and analyzed each other's posters. The students were to give each other questions about the poster and any comments. The teacher moved around and helped students. There were two seniors from a nearby college in the class who helped as well. Students needed a lot of help in analyzing each other's posters. The teacher and the two seniors had to give them examples. For example, Lisa asked students the following questions,

" Is it clear to you why this is a community? Can you explain the relationships among organisms based on what you see? (Some students drew animals that could be found in three different continents)(Field notes/May 2000)

After the group work, students were expected to redo their posters and prepare for a presentation the next day.

Commentary

Why is this embedded assessment? There are many features of embedded assessment in day two. Firstly, the teacher realized that the posters were not detailed enough and some had inaccurate information. The teacher was analyzing what students had written, so this enabled her to decide what to do the second day. Rather, than her telling students what was wrong and missing in their poster, she asked students to critique each other's work. But then most students had no skills for doing this so she and the seniors helped to

show how this was done. This is embedded assessment that she is doing as the lesson occurred. Based on the feedback from peers and the questions asked by adults in the class, students had to redo their posters. This is an example of embedded assessment because they have more than one chance of learning the same principle. Her decisions about instructional strategies are based on students' work, so as to move them further in their understanding of ecosystems and flowering plants.

Day Three

Students presented their posters to the class. The teacher graded their presentations. During the presentation, Lisa constantly asked students questions like "Where in the world does this ecosystem exist?" For example, if they drew elephants and lions, it was proper for students to say this would exist in Africa. She asked for the food webs and food chains that would exist in the ecosystems. She also asked very specific questions like "*What does a butterfly do with the flower?*". I was puzzled by the fact that most students did not ask a lot of questions to the group presenting. It was mostly the teacher and a few students who gave comments. Lisa commented that she did this after the ecosystem unit and the flowering plant unit, because she was expecting students to integrate the two in their posters. Lisa collected the posters and the written information and analyzed them. She gave written feedback for each poster. An example of her comments was,

"What will the animals in your ecosystem eat? Where will your animals get the oxygen? What do you think will happen to the waste product? What purposes will the plants serve? What are the most common relationships in your community?" Most of her comments were in a question form; she also acknowledged the good work and effort (Field-notes/May 2000).

During professional development meeting three, Lisa shared with the other teachers what she had done with her students and what she was learning from it. This will be discussed further in the section on the impact of embedded assessment.

Commentary

What does embedded assessment look like in Lisa's classroom? Lisa reported that if it was not for the embedded assessment project, she would have just done day one and moved on to the next topic. When we consider these three lessons, Lisa's students are speaking more than before, e.g., in-group discussions and presentations. They were engaged in the discussions and presentations. Lisa guided the discussions, even though most of the questions came from her, rather than the students. Lisa was not just giving them information; students also presented their thinking. They were constructing their understanding of the ecosystems from various sources: the teacher, their peers, textbooks, themselves and seniors from Michigan State University. In this situation Lisa was not the only source of information. Her students were discussing within their group first; then, they got feedback from their peers and the teacher. Their presentations had accurate science content about ecosystems because they had more than one chance to do the posters. An example is their ability to see multiple relationships between organisms and non-living things and their environments. Some students wrote that squirrels eat oak trees' acorns, and oak trees' seeds are planted by the squirrel (field notes/ May 2000) and using knowledge that they learned in the unit. Lisa commented that she was confident that most of her students understood this topic very well, such that most of them performed better than before on the end of unit test.

Analytical commentary on the journey of Lisa Leslie in the embedded assessment project

Lisa Leslie passed though three distinct phases in this project. One was total rejection of embedded assessment due to logistics. Lisa had genuine and convincing concerns about embedded assessment. She tried embedded assessment in her classroom but this made the situation worse than before. Not only was she recognizing the constraints, but also she was experiencing how hard this was and how it presented a lot of problems for her. Lisa complained about this project in the interviews and during professional development meetings. My intervention led to Lisa's breakthrough and Lisa designed her own ways of dealing with some of the constraints (to be discussed later). The interaction between teachers and students changed. The kids started responding in a different way because she started paying attention to their ideas. She also used samples of student work as a basis for discussions. Students' responses were also an encouragement for the teacher to do more embedded assessment. Lisa described how she was making sense of embedded assessment:

> *What this project required was to use the kids' exact work that they did, and show them where they were right or wrong and be very specific about it. Right, not generalized to the class but specific to the individual. I need to respond to the sentences each child writes and then measure the future sentence that he wrote against his previous sentence and the student should do that also on their own...embedded assessment is really quite individualized. Teachers need to teach individuals and not groups... this is different from an institution, which is a factory for kids, a factory for teaching (LL/interv5/p26/May 2000).*

Lisa's understanding of embedded assessment was becoming more complex. She was starting to focus more specifically on individuals. Lisa argued that kids should be

treated as individuals, not as groups, and she saw embedded assessment as helping her in that direction. In summary Lisa's understanding of embedded assessment included:

- It has different levels meaning, you can do it for groups of students, for the whole class and for individual students, or you can do it orally, written or drawings. You have a variety of opportunities that can help you assess kids' understanding.
- Allowing kids to talk and using part of their talk as part of the lesson
- Have kids write and use what they write as part of your lesson
- Addressing misconceptions that the teacher knows from the wisdom of practice and finding what confusions kids have as you teach
- Individualizing help to students; individualized instruction and individualized detailed feedback from written tasks

These ideas represent a fairly sophisticated understanding and use of assessment compared to her views and practice before her involvement in the project. Now, that I have described her journey, I will now specifically discuss how this was impacting Lisa Leslie.

Impact of embedded assessment

Assertion # 2

Embedded Assessment influenced Lisa Leslie's classroom and her views about students, assessment, planning and teaching even though Lisa struggled with pragmatic issues

The following section will discuss the impact of embedded assessment on Lisa's classroom and her students, teaching, assessment planning and reflection. I will close this

section on the impact of embedded assessment project by giving an analytical summary of the impact of embedded assessment as a whole.

1) Impact of embedded assessment on Lisa Leslie's classroom and her students

This section on the impact on students will be discussed in three parts: the shift in focus from teacher to students, the realization of the importance of students' ideas, and a focus on writing to learn instead of writing to evaluate.

A shift in focus from teacher to students

This project impacted what happened in Lisa's classroom. She now wanted her students to do more activities, to talk more both among themselves and during class discussions than she did previously. This was a contrast to her comments in the first interview that she wanted to be the director of most of the things that happened in her classroom. There was a shift in who was in the center of what occurred in the classroom. It was now the students and not just the teacher. Lisa hoped that by doing all this, it might help with understanding. She referred to this as moving the kids from short-term memory to working memory and then finally long-term memory.

> *You have to have kids actually do something to learn. Apparently there is a belief out there that most of what is presented in life your brain records it. Like the movie records everything or it doesn't. You have a short-term memory and a working memory. And when we talk to kids and get them to discuss what we are showing on paper, we have a better chance of moving from short tem memory to working memory and then we might get it to long term. But if we do not get them to discuss, basically it is in the short-term memory for the length of whatever time you have or whatever time span. And they walk out of your classroom and totally forget everything that they have learned, which is why a child may seem to understand and then come in next day and they have totally forgotten everything they have learned,*

which usually drives us nuts, because we are thinking but you got it yesterday (LL/interv3/p7/ April 2000).

This to me indicated that Lisa was trying to help her students move towards understanding concepts in a way that they could remember it. She was trying different strategies; for example, group discussions, peer reviews and class presentations to accomplish helping her students understand scientific concepts. Before learning about embedded assessment, Lisa did not mention such advanced analysis of students' work, which suggests that participation in this project was causing her to think about it. Also, during the project, Lisa attended a meeting on brain research and learning which was conducted by David Sousa and was sponsored by her district.

Lisa believed that embedded assessment helped with identifying suitable learning styles for her students, and with adjusting her teaching to suit those learning styles. She further argued that teachers should match teaching style with learning styles.

There should be a way that kids are matched with teachers. By the time they are in third grade, teachers know that this kid cannot sit still. These kids like to be quiet, this kid needs a highly structured environment, and this kid likes to explore stories. And if you could match teachers' teaching styles with kids' learning styles, that is what we are learning from embedded assessment...Like this kid need more background, this kid is advanced (LL/inter2/p7/March 2000).

Lisa also questioned the pragmatic side of matching kids' learning styles with teaching styles because classes have twenty-five kids and most of the students have different learning styles. This makes it difficult for the teacher to meet the learning styles of all her students. But here we can clearly see that Lisa was now seeing embedded assessment as a tool that helped her to diagnose her students' learning style so she can tailor make her teaching styles.

b) Lisa realized the importance of students stating their ideas: 'the power of their ideas'

Lisa commented that this project had made her realize how important it was that students state their ideas. In her final interview she said,

> *With this project, I have realized how much more important it is that they state their ideas clearly. If they cannot state their ideas, you cannot assess them accurately. If they cannot express their ideas orally or in written form, then it becomes hard to assess. So, if so much of their ability to state things clearly is tied into their ability to write and their ability to put a complete sentence, then I have to start with that. This is what I expect in science, writing complete sentences (LL/intrev5/p6/ May 2000).*

Lisa had realized that kids do have ideas and they should be given a platform to speak their ideas. In this way she would be able to assess and design activities that help them move further in their understandings. This realization made Lisa see the importance of treating her students as 'knowledgeable' and not as "empty vessels" waiting to be filled with knowledge. In this quotation, Ms Leslie notes that sometimes students may not be able to express ideas on written tasks because of their writing skills. The power of students' ideas is her acknowledgement that kids are thinkers and that these ideas help her to adjust instruction. This is powerful because it helps her students to articulate what they know and it also helps her to plan lessons that address students' difficulties.

c) Ms. Leslie focused on writing to learn instead of writing for evaluation

This project had influenced Lisa in that she required her students to write more in science. Before this project she used worksheets and this project had made her realize that this kind of writing is not effective if she wanted to know what her kids' ideas were or what they really knew. A different kind of writing than worksheets needed to be used, one that revealed what her students were thinking, what they knew, did not know and what they were confused about. She said,

> *What was the biggest component? I look at this whole thing and I am saying it is writing skills...I had to assess their writing skills, which I usually do not assess, and their critical thinking skills. Since their writing skills are so bad, they cannot state their ideas on paper and so we had to focus on those. We did a lot more written work and it bothered me that it took so long. But I would rather they did two perfect sentences with a clearly stated idea in them (LL/interv5/p06/ May 2000).*

The purpose of this kind of writing was not to be tested or graded, but to communicate what you knew or thought. By giving worksheets that required one word answers or definitions that could be easily picked from a textbook, the writing assigned previously in her class was mechanical, conceptually weak, poorly focused and overly routine. This was actually a deep awakening for Ms. Leslie yet at the same time frustrating, because she realized that what she was doing for years was not assessing accurately. She then stopped everything she was doing and concentrated for about a week on helping kids write sentences that expressed their ideas clearly.

The teacher believed that while using embedded assessment, her students had to write a lot so that she could be able to assess them accurately.

> *Because of embedded assessment, I realized how hard it was to accurately assess the kids without having them write things in their own words. I have realized that their writing skills are not where they should be in order for me to accurately assess them. And I have realized that I would have to start at the beginning of the year building writing skills, doing peer editing, get them in the habit of doing all this and it is what I have decided to concentrate on for the rest of the year, while involving them in plants and I am also thinking it's kind of too late in the school year to realize and the kids are rather resistant to working at this point (LL/interv4/p18/April 2000).*

This comment showed a renewed concern for helping kids write in science. At the beginning of this study, Lisa thought that writing was for the English teacher, not the science teacher. Now she was realizing that it was important in science as well. Writing had become a focus in Lisa's classroom. This project helped Lisa see the importance of helping kids write to express their thinking and ideas. Writing became a critical issue for Lisa such that at

the beginning of the 2000-2001 school year, Lisa specifically focused on developing writing skills so her students could become accustomed to it.

2) Impact of embedded assessment on Lisa Leslie's teaching

a) Lisa tried something 'new' in her teaching

Lisa tried new strategies in her teaching and adding to her repertoire. Lisa did this because we gave teachers the assessment strategy booklet in the professional development meeting. She described this by saying,

> *I have decided to try a few things that I have never done before...next week, I am going to put them in groups and I will give them a task to teach their peers about a particular concept. They will have to figure out how to teach a lesson showing what they know about that topic and something that is a true concept and they must have a visual aid to help their peers understand (LL/interv3/p23/ April 2000).*

The teaching strategy that Lisa used for this lesson is often called the 'you be the teacher' strategy. As described earlier, at the start of the project, her classroom was very much teacher-centered. She alluded to this point when she said she saw her role as that of a director. But in having students teach others, she was partly giving up her class to students, although she was still in charge of organizing and managing the groups. This showed a gradual shift in her teaching and a change in her conceptions of her role and that of her students. She realized that students had to show what they know and now she was willing to let them teach their peers.

b) Lisa focused on the process and giving constructive feedback

Lisa believed that embedded assessment helped her to focus on the process of learning and teaching. She believed that this in turn helps with the product. An example from her teaching is given below.

"Everything we do with embedded assessment needs to be a process kind of thing instead of the end product...It has taken me three days to read and give feedback on what we did on Thursday..... To actually read through and find what they are thinking and adjust your teaching to it"(LL/interv4/p2/April 2000).

Lisa was reading students' work carefully to find what they were thinking with two purposes in mind:

- to adjust her teaching, i.e., tailoring her lessons based on what students wrote
- to give feedback for each written task so students could rewrite.

This was a different kind of feedback, which focused on probing students' thinking, rather than just grading. Lisa struggled with not giving a grade so she ended up giving a grade plus constructive feedback. She required students to use the feedback to rewrite their responses. She commented," *I do not believe that I should take a lot of time on something that I do not give grade for, so I had to grade, plus I gave detailed feedback which students used to rewrite their responses" (LL/interv4/April 2000).* For Lisa, feedback was not merely a label anymore; it was an essential part of learning. Assessment should improve learning, not just evaluate it. This requires that assessments embody and demand self-adjustment based on good feedback. Thus Lisa expected her kids to use her feedback to rewrite. This is a different stance that Lisa was taking compared to traditional testing. It is a radical idea to give the students self-evident feedback while being assessed. In many instances it would be considered cheating. Before embedded assessment, Lisa would just put a grade or points. As

I have discussed in the section about Lisa' s journey, Lisa had a turning point in her teaching, which I will elaborate on in the section below.

c) Lisa's turning point in her teaching

In this section I will revisit Lisa' s turning point and focus specifically on how it impacted her teaching. In interview number four, Lisa described her turning point by saying,

> *You started realizing that what you thought they knew and what you thought they learned, they might have just been guessing. They might not have really learned it, that it was reading something and recognizing a word in the answer that made them choose that. But if you use embedded assessment accurately, you need to see them write something that comes from their own knowledge, from their own internal idea and so you use open-ended responses, rather than multiple choices or fill in blanks. The results are so vastly different such that I did not know if they learned anything the entire school year, because that is what I used most of the time. This was very depressing for me and I stopped because I could not handle the thought of wasting my time and kids' time all these years they have sat in my classroom (LL/interv4/p43/ April 2000).*

Lisa was an experienced teacher who had seven years of teaching experience. This comment came in April; three months after the study had started. It was really hard to 'sell' the idea of embedded assessment to her because she held tightly to her ideas about what works in the classroom. It was changing her assessment strategy that brought about change in her teaching. When she changed from using multiple-choice and fill in blanks worksheets, she realized that her students did not really know a lot about what she was teaching. The change in her teaching was actually focusing on writing more and expressing what they knew. She alluded to this point by saying,

> *This project has made me realize what I need to do better. I need to look at writing skills and use more in depth writing than what I usually do, i.e., fill in the blanks. I*

want them to write paragraphs and show their thoughts and evidence, really increase where they have to tell me their conclusion in their own words, because If I am using short answers it is not enough for me to judge what they really know (LL/interv4 p4/April 2000).

This quotation to me means that Lisa was concerned with helping kids understand and to show what they understood. So, what had changed for her is what she required as evidence of learning, whereas before the grade was the evidence of learning.

3) Impact of embedded assessment on Lisa's views and use of assessment

a) Lisa used embedded assessment to find student difficulties

Lisa became more skilled in using embedded assessment to find her students' difficulties about a particular topic. This enabled her to plan lessons to address those particular difficulties. Lisa said," *Embedded assessment makes you start from their inabilities but sometimes you get kids that are way below the starting point, that means you cannot start at the beginning of where you are supposed to start" (LL/interv3/p33/March 2000).* Even though this quote was about the beginning of the unit, Lisa continued to find what students' difficulties were daily and not just at the beginning only. I saw her use of assessment here different from what most teachers use as pre-assessment. They use pre-assessment to find where their students are at and this is done at the beginning of the unit. The difference here is that, in embedded assessment, you are continually finding the difficulties your students are having, as you teach throughout the unit, not just at the beginning. Lisa had good knowledge about the difficulties her students had on particular topics based on her seven years of teaching experience. Examples of some of the difficulties she pointed out were:

- Students do not understand the idea that things cycle through, like the water cycle.

- They treat plants as if they were people that have feelings.
- They do not understand that apples are harvested purely for their seeds so that they could be planted.
- They believe that seeds are there in an apple to annoy them when they eat (naive conception).
- She said students do not understand that if she takes an apple, which is the ovary of the plant,[6] and plant it in the ground; it becomes food for the seed. (LL/interv3/p23/March 2000)

She was using these difficulties to plan how to address them in her teaching. This study had impacted her in that she does not teach a topic and move on; she now looked at problematic areas and misconceptions, and designed appropriate teaching strategies to address the difficulties, naive conceptions and confusions. For example, to address the idea that things cycle through, Lisa gave students a ' mind stretcher'. She provided students a cartoon showing a person, a tree, grass and a bird. She asked students to draw arrows that show how carbon dioxide, oxygen and water are exchanged among these organisms. Students were also required to explain how/why these gases moved between these organisms. (Fieldnotes /April 2000)

b) Ms Leslie realized the importance of strong science content knowledge

Ms Leslie learned that, to use embedded assessment effectively, she had to have strong subject matter content knowledge. This enabled her to pick up misconceptions and confusions easily. In topics where she was uncomfortable with the content knowledge, it was challenging for her to use embedded assessment. In fact, she discovered that she had

[6] I am not sure about how accurate the science content is because teachers also have misconceptions about the science content as well

many misconceptions, which if not addressed, would be passed to students. In interview number 3, she acknowledged this,

> *When you are not comfortable with the subject matter content knowledge, it's harder to use embedded assessment, because I don't know what misconceptions to look for. I do not analyze their work effectively so I can give good feedback. Also, when I started teaching, I did not know where to start on particular topics. I automatically thought the kids knew for example, that the earth is a sphere, the sun is part of a solar system, and it is a star, but they didn't know that. All these things kept making me go backwards than I originally started with (LL/interv2/p6/March 2000).*

4) Impact of embedded assessment on planning and reflection

Before Lisa learned about embedded assessment, she planned daily as she did during this project. But what was different was that now she was connecting lessons together. This, she believed, gave a comprehensible whole for the student, rather than discrete unconnected lessons. She also used student work to guide her decisions about strategies to use and what direction she needed to go in her teaching. If her students did not understand or had confusions about water cycles for instance, this is what she would focus on. Embedded assessment was giving her a systematic way of planning, based on evidence from students' work. In interview three, she said,

> *This project has made me aware when I plan my lessons, a policy of connecting lessons together, to say do you see how this ties in with that or this, and try to use something we have learned before, with whatever we are learning now as a tie in. And especially to use their work to make them understand (LL/interv3/p18/March 2000).*

She reported that when she planned for embedded assessment purposefully for a week, and then gave an end of week test, all her students did well on the test. Her goal in doing this was to see whether this really made a difference in terms of kids learning and in dealing with tests. She worked hard to use ongoing assessment and include all the features of embedded assessment. The students were studying the unit on ecosystems. She reported

that she was particularly impressed with one student who normally did not do well but performed exceptionally well this time.

> *I did do that planning for embedded assessment for a week when I did murals. They had to work in groups and come up with an ecosystem and revise that mural based on my feedback and that of other students in the class. They also had to do a review of the major concepts for the ecosystems unit. I am really getting good grades on that unit specifically on the test given. You can see the questions I asked, they were about finding what they really know about ecosystems. We revisited key concepts several times using different strategies..... I was impressed with one student who got 80%, he would not be the one that I would choose as doing really well on a test, let alone anything he writes (LL/intrev6p5/Juve 2000).*

This teacher planned systematically for embedded assessment and her kids had more than one chance of learning key ideas. She saw the results of her work in that most students did well. She also received a surprise, one low achieving student performing exceptionally well for the first time. This was exciting for Lisa. She commented in interview six that,

> *Kids who are taught this way are likely to perform better in a standardized test because part of it is the writing skills, which I admit I am concentrating a little bit more on because of this project. I am focusing on bringing up their writing skills (LL/ interv6/p1/ June 2000).*

Even though Ms Leslie believed that this helped with performing better in standardized tests, this is an open question, as I did not collect data on students' performance on standardized tests.

The table below summarizes the key components for the case of Lisa Leslie in terms of the impact.

Table 5.1 Influence of embedded assessment on Lisa Leslie's views and perspectives

Key Component	Before E.A	After Introduction to E.A.[7]
Roles	Teacher is the director of learning	Teacher became the interpreter of students' work, facilitator of learning, provider of feedback and designer of lessons to address difficulties
Views about students	Cannot help all of them; outside of school life impinges on success	Sees students as capable of learning because they have ideas that can be used to further their understanding
Views about teaching	Tried to push for understanding rather than factual recall	Lisa tried 'new' teaching strategies such as peer reviews, 'you be the teacher', class presentations. Embedded assessment became a tool to teach for understanding.
Views about assessment	Used worksheets and fill in blanks type forms of assessment. Teacher usually gave grades and moved on to the next topic.	Teacher focused on writing to learn, writing to express thinking and to state scientific ideas clearly. Teacher gave constructive feedback. Teacher revisits concepts that are not completely understood.
Views about planning and reflection	Picks objectives from the school district and plans activities for them. Reflects during summer.	Lisa connected lessons together and based her planning and reflection on classroom events.
Classroom environment	Teacher dominated, teacher is the center of events.	Students' ideas became the focus in the classroom.

From table 5.1, we can see clearly that embedded assessment had a profound impact on the teacher, students and the classroom environment. But we will see in the next section

[7] E. A. denotes embedded assessment and the column represents Lisa's views after she was introduced to the idea of embedded assessment and not after the project was completed.

that this was not easy for Lisa. It was a journey that was marked by doubt, uncertainties, tensions, problems and breakthroughs. In the next section, I will further elaborate on the kinds of problems and tensions that Lisa faced through out the project.

Assertion # 3

Lisa faced enduring tensions/problems and challenges in the process of learning embedded assessment

This section describes problems, challenges and tensions that Lisa faced as she tried embedded assessment in her classroom. I call these 'enduring tensions' because they are not new. They come up in any educational innovation. I have organized these problems into the following categories: problems that relate to Lisa and her conceptions of teaching, learning and assessment; problems that relate to her students; problems that relate to the school as a system and societal problems that influenced what happened in her classroom.

Problems that relate to the teacher and her conception of teaching, learning and assessment

Earlier, in the second phase, I described how Lisa compromised in her use of embedded assessment, even though she understood what it meant. This was beneficial for her practice because she found a way to be comfortable in using it. But it was also problematic, because it compromised the essential features of embedded assessment, i.e., that it is an integral, cyclical and ongoing process. The compromise results in what Deborah Ball (1996) refers to as 'little piece meals that are unconnected.'

Embedded assessment is influenced by how the teacher understands it, whether she buys into the idea and if she is excited about it. Lisa questioned the pragmatic aspects of embedded assessment in the first professional development meeting. She was not excited

about it. This may have influenced what she did in the classroom. Her established beliefs, values and practices interfered with her ability to do embedded assessment as the project envisioned it. Her conceptions about students and what they were able to do influenced her ability to enact embedded assessment. As cited before she believed that, '*you cannot help all students.... they have too much trouble from their homes, that makes them less concerned about schooling' (LL/interv1/p20/March 2000).* This shows that the teacher did not see some of her students as knowledgeable and able to learn. But this changed later on in the project.

I will summarize the key problems and challenges that Lisa faced below;

- Her experiences and beliefs about teaching learning and assessment
- Her conception of embedded assessment
- The social settings around her: classroom, school, peers and district
- How she viewed her students and what they were able or not able to do
- Her energy level about embedded assessment
- Her science content knowledge

The teacher also had a problem with how she perceived my role and that of other researchers in this study. The expectations for the teachers in this project were described as follows:

> *We want you to think about how you can adapt this approach, of gathering information about your kids' ideas and then trying to understand what it means and then responding in terms of using that information, you will be able to know your kids' misconceptions, difficulties that students are encountering to improve or modify your lessons so that you respond to those misconceptions R/pd1/p14/March 2000).*

The project did not intend to hand teachers activities to use, which is a common trend in most professional development. Instead, the teacher had to do hard work for this

project and this might explain the lack of excitement because the teacher was realizing how much work she had to do. We were not going to give teachers a 'recipe' to follow nor did we expect them to implement a tool. Rather, it was to be a study of how they were making sense of it and how they enacted that understanding in the classroom. The embedded assessment framework for this project recognized that teachers' understanding of embedded assessment would have to entail personal invention; it can never be simply transmitted from a generator to a recipient, but had to be constructed from the learner's own experience and intellectual work. This was problematic for Lisa, because she was accustomed to attending professional developments that give her "fun science activities" to do in her classroom. Lisa commented on this mismatch with her expectations,

> *I do not think we were given specific embedded assessment activities to do. We were not given enough ideas in the start. We talked about embedded assessment and we had a couple of examples, and I had a kind of idea what it was, but I was hoping to be given specific activities to try out with my kids (LL/interv5/p8/May 2000).*

Her breakthrough in this project came because I suggested that she use open-ended questions. I did not give her those questions. She had to come up with the questions on her own.

Problems that are associated with students in her classroom

Ms. Leslie expressed her frustration about kids that do not take their education seriously.

> *The biggest frustration about the whole thing is the kids who do not take their education seriously. But that has nothing to do with embedded assessment. Embedded assessment cannot help that. Some students have no intention of doing a*

bit of work...they do not care about school...school to them is for socializing. (LL/interv5/p26/May 2000).

The above statement to me means that the teacher did not see a connection between embedded assessment and motivation of students. Yet in the impact of embedded assessment, she indicated that student participation increased when she used embedded assessment. Another interpretation of this statement is that the teacher was alluding to her students' attitudes towards science and school in general. In using the embedded assessment approach, there are some requirements for students, for example, they have to be willing to think and share ideas and participate actively in class. There is a certain kind of a learning community that needs to be established. Lisa talked about this when she complained about starting this project at the beginning of the spring semester instead of fall. She saw this as problematic because the learning community was already established.

Embedded assessment enabled Lisa to see what knowledge base students have or do not have, so they can make that their starting point. Lisa was disappointed that some of her students did not have the knowledge base that was expected for 7th graders.

> *They are so skill deficient that you try and build on a knowledge base that is not there, with skills they do not have, it ends up frustrating...embedded assessment helps you to see where exactly they lack skills, but in a way it is depressing because you see how far behind they are, but you cannot re-teach all that, and you still have your curriculum that you are required to teach, and I am thinking I should throw out my curriculum and help these kids with reading for information and writing skills, and yet I will be judged on whether they know science.... I am stuck (LL/interv4/p3/April 2000).*

Lisa saw that embedded assessment helped to reveal that her students were missing basic foundational knowledge like reading. She questioned how she could teach science to kids who could not read. Her tension was, "Should I teach them to read and write, or should I teach them science?" The school system does not support her in helping kids who lacked

those basic skills. Instead she was supposed to teach the prescribed science curriculum from the district. I will summarize below Lisa's description (in interview number six) of the factors that pose challenges for her with regard to doing embedded assessment:

- Her students were skill and knowledge deficient. She said students did not have the required knowledge base to build on, e.g., poor writing and reading skills.
- Her students saw no difference between concepts/facts, specific and non- specific, they could not draw conclusions (teacher based this from analyzing their work)
- They (students) wanted step-by-step instruction on what to do. They could not do independent work and be focused. (Note that this changed after embedded assessment)
- Students were resistant to this kind of teaching at first especially if they did not buy into it.
- Some students did not turn in assignments for the whole semester. Lisa pondered on how she should know their misconceptions and confusions. (LL/interv6/June 2000)

These problems presented challenges for Lisa that she dealt with in her own way.

Problems that relate to the school as a system

Lisa used the 'assembly line' analogy to describe the limitations of the school system. She believed schools function like 'factories' and this was problematic for embedded assessment and for educating children. She explained her analogy below,

> *In 1st grade they are supposed to learn this, and second, third all the way to 12th grade. We add on pieces at each grade level just like in an assembly line in a GM factory. We are trying to turn out an end product: an educated individual who knows basic facts, science, social studies etc who is able to communicate both orally and in written form and can use technology. That's all fantastic. Just like GM which turns cars But you know what? Both cars all start out the same. The kid that comes into kindergarten is not the same as any of those kids. They are all starting at different places and we are trying to add on to a piece and yet there are no connecting pieces.*

There is no place for it to add on, because what you are supposed to add to is not there (LL/interv6/p19/June 2000)?

Here, Lisa described how the school system treats kids as if they were machines that start at the same place every year and end up at the same place. There are no connecting pieces among grade levels, i.e., the curriculum is not coherent. I summarize below the elements of the system that Lisa saw as problematic for her.

- Class size (Interv2/p7/march2000)
- Administration that puts everything on teachers and is only concerned about the MEAP scores (Michigan Educational Assessment Program). The administration at her school was not supportive in her involvement in this project.
- Lack of support by other teachers at her school.
- Balancing embedded assessment and curriculum requirements and still having a life
- Students are in a 'race' in the system and embedded assessments revealed that some of her students were below the starting line of the race, and yet the system is not organized to help those students (Interv6/p29/June 2000).
- The system is structured like an assembly line and yet embedded assessment required helping all and treating kids as individuals with differences.
- Lack of time within the school system to talk about embedded assessment and to teach for understanding

What embedded assessment seems to be saying is we want you to take this kid in kindergarten and individualize his educational process so that when he comes out of 12th grade, he does not fit a mold. He is the best individual he can be, because we are all different. Well, you cannot have both models at the same time. The model of the school fits the assembly line. Add this every year. How do you individualize an assembly line? You cannot do that and make it cost effective (LL/interv5/p11/May 2000)?

This was not an accurate view of embedded assessment but it presented how this teacher was making sense of it. This was her understanding of embedded assessment.

Problems that relate to the society

Lisa believed that her students bring societal problems to the classroom. Lisa complained about lack of parents' involvement in the education of their children. Lisa believed that if parents supervised the kids' home environments, they would be capable of completing assignments. Her students would have a better attitude about school. She said,

> *When they get home from school, some take care of brother and sister; no one asks them if they have homework.... Some of the parents are not confident to help their kids with homework... some of my kids all think they will be in the NBA (National Basketball Association) and the girls will marry millionaires, and they do not need the education... some parents think teachers do not care enough about kids and put less effort...some parents are defensive about their kids and deny reality...some parents have problems of their own like drugs, alcoholism (LL/interv 6/p24/June 2000).*

I agree with Lisa that some of her students come from unfortunate home environments. I encouraged Lisa to focus on what she was able to do with her kids' time when they are in her supervision that would be memorable for the students. This gave Lisa a different mindset that allowed her to have a positive attitude and give her best effort in her job.

Analytical summary of the case of Lisa Leslie

Lisa Leslie was a science teacher who had many years of teaching experience. My first interview with her led me to believe that she would swim easily through the embedded assessment project, because of her views and beliefs about teaching and assessment. However, my observations of her classroom showed me that there was a difference between what she said and what she did in her practice.

Lisa participated actively during the professional development sessions. Her journey through the embedded assessment was marked by three phases of rejection, complaining and a turning point. The turning point enabled her to look closely at what her kids were writing and to use that writing as a basis for planning her instruction. Doing this resulted in some changes in her thinking about teaching, learning, assessment and her role and that of students. This was not an easy journey for Lisa. It was filled with tensions, challenges and problems. The professional development meetings provided Lisa with a support system, so she continued with the project even though there were some problems. After her turning point, Lisa changed her talk and her focus. Her talk became focused on the things she was doing rather than on things she saw as problematic about embedded assessment. Lisa focused on how she could make this tool work, given her working conditions, which she saw as stumbling blocks for her to do embedded assessment effectively. Because of all the problems, Lisa constructed her own way of doing embedded assessment, which was not consistent with the embedded assessment framework but worked for her. The next chapter will look at the next case, the case of Sarah Williams.

CHAPTER SIX: CASE THREE

CASE STUDY OF SARAH WILLIAMS

In this section I will start by introducing Sarah Williams and the context in which she worked. I will discuss her goals and conceptions of both her roles and students' roles. I will then move on to discuss her views about teaching science, what she knew about assessment and how she planned and reflected. I will end this section by summarizing what kind of teacher I thought I had for the embedded assessment project.

Who is Sarah Williams?

Ms. Sarah Williams was in her middle thirties when she decided to participate in this project. During this study, Sarah was in her first year of teaching middle school science. She had seven years of teaching experience, two in elementary school, and five in middle school social studies. She brought her elementary science teaching experience into the teaching of seventh grade science.

> *What I like to do, when I taught elementary school, are more hands on, getting the kids involved, using the kids as the props that I need. I did that a lot in elementary school, and I brought that here. If I am doing a food chain and we talk about what happens and then we demonstrate space as the habitat and we put so many people in that space and see how comfortable they are.... kids enjoy this and they get to have a discussion about what happens. It makes learning exciting (SW/Interv1/p2/March 2000).*

Sarah did her teacher preparation at Michigan State University. She liked the elementary science methods course better than all her education courses, because they learned the science teaching methods and at the same time they were teaching at an

elementary school so they could try the methods they learned. Sarah was asked to teach science because there was a shortage of science teachers at her school and she had a minor in science.

During the first week of observations in Sarah's class, I noticed that students talked a lot about their experiences and their thoughts about science concepts. Sarah responded to this by saying,

> *This is important for a variety of reasons. First of all, it shows how their lives are connected to what we are learning. I ask questions that do not require yes or no, I say why? How come you think that? What are you going to do about that? I want them to continue talking. So they are used to that (SW/nterv1/p3/March 2000).*

Sarah saw that importance of connecting subject matter to students' lives. This, she believed helps students to apply the knowledge they learned in science classrooms to their lives. Sarah's practices of questioning and encouraging students to talk provided her with an entry point into the embedded assessment project. But notice that she did not say that she asked those questions so that she could assess their understanding, she ties it to connections to kids' lives, but not to assessment.

Goals and roles

When I asked Ms. Williams about what her roles were and those of students, she responded by saying, "*sometimes my role is to be an instructor. Sometimes my role is to be a facilitator. It depends with what is going on in the classroom.... Students I see them as both learners and teachers" (SW/interv1/p9/March 2000).* Ms. Williams explained that 'learner' implied that students have to listen, pay attention and engage in learning

and discussing. By 'teacher' she meant that they are the ones presenting and leading the group, they are instructors to other students. Sarah seemed to lack a clear focus.

Sarah described her goal,

> *One goal is to actually teach to the curriculum, so that I am covering what needs to be covered for seventh graders so they do well in eighth grade science. Another goal, is to have fun teaching science and to actually see that students are learning what I'm teaching in science...my biggest goal is to help them survive school (SW/interv1/p10/March 2000).*

By surviving school, Sarah meant performing simple things required in school e.g. attending class on time, bringing all equipment and doing what you are expected to do. Sarah volunteered in this project because she thought it would help her with her confidence in teaching science. She reported that she was eager to learn new ways of teaching and assessing.

Teacher's views on teaching

Sarah's views on teaching in general include teacher flexibility, i.e., to be able to change plans, knowing subject matter content knowledge, knowing students and their needs and teaching to those needs. She talked about this in the first interview,

> *Best practice to me is to continue to try things until they work. Things that work with one class might not work with another class. So, it is important to be flexible, to be able to change just like that. I need to regroup but it is hard. You need to be familiar with your information that you are teaching. You need to be familiar with your students that you are teaching and know their needs. You have to constantly change until you teach to their needs (SW/interv1/p4/march2000).*

This view of teaching distinguishes Sarah from most seventh grade teachers because most teachers teach, test and move on and they do not change their plans to accommodate students' needs. Sarah, in this instance seemed as if she would be a good candidate for embedded assessment because she said that you have to constantly change

until you teach to their needs. What is interesting about Sarah's case is that she tried to do all the things she talked about in the interview. I was able to see some of these points of view in her classroom. She expanded on this by saying, "*I started doing hands on, working in groups, doing a lot of things that they enjoy like cutting out articles or reading as a group and answering questions, doing group things where they interact with each other" (SW/interv1/p4/March 2000).*

Even though Sarah tried these things, she observed that some of her classes did not respond well and she had to change her strategies to suit her students. For example, she said,

> *Some of my classes did not do well, they could not handle that much freedom. This class that I have, they like to have boundaries and so I had to change to have more structure, and they did better in that king of setting...and it is also important for me to involve everyone (SW/interv1/p4/March 2000).*

My understanding of what Sarah was talking about in this instance is that she tried different management strategies and the change was based on how her students reacted to her strategies. **Her adjustment was based on how students behave and not how they respond to the concepts presented.** This seemed different with embedded assessment, which places student work and talk at the center of adjustment of instruction. The reactions of her students were social and not cognitive. It seems to me, that teachers readily adjust their classroom management strategies based on student behavior and embedded assessment is the cognitive side. In using embedded assessment, teachers adjust instruction based on how their students are making sense of scientific concepts, i.e., the cognitive side. Sarah did not do adjustment because of how her students responded to concepts. Generally, I would conclude that Sarah was not focused on learning but on managing behavior.

Context

Sarah taught with a team of three teachers. They all teach 3 different subjects. They did big groups things together, for example, checking the register, reminders of what was due and the schedules. She explained below how the three teachers worked together.

> *So, how our team works, we have three teachers, and we have four subjects, and we have this large area. We decided we do big group things to get our first study skill activities, like today we are doing the senses...We are talking about the senses and how that works. Umm, and then, we have core time different days of the week, where a different subject.at a different time and they, they just rotate through the classes where they get all the subjects that they are due to get. Umm, and sometimes, there isn't an extra teacher because we are only teaching two classes at a time, that extra teacher usually will help with one of the, who ever needs, say I am doing that game, yesterday. Well, Ms. Smith was the one that was floating, if she came out and she helped me with the game. She is just as much a teacher as I am. She knows the lesson. She will jump in and take over, or I will jump in, you know, we just bounce off of each other as far as talk, we interrupt each other all the time, and then, it works nice for us. That's how we are used to it (SW/interv1/p5/March 2000).*

Because Sarah was already collaborating with three teachers on a daily basis, this helped support her professional development in working well with colleagues. Sarah believed that the team concept of teaching is good because she gets to know one group of students and their parents very well and she works closely with her colleagues every day. She believed that she was not stuck alone in a classroom without adults. From my observation notes, this was of benefit in science experiments and also in behavior management. The teachers closely worked together to monitor both behavior and the learning of their students. On the other hand, Sarah also thought that there were problems in working with other two teachers because she reported that in her

experience, she had seen problems and difficulties when working closely with others. This was due to conflict that arose when people did not have the same beliefs or ideas.

Sarah and her colleagues worked with a cohort of about 60 students. A third of the students were special education students. There were 29 females and 31 males. One of the teachers was a special education teacher. Sarah believed that students learn best when they watch and do something. Some of the activities that her students were exposed to this year included,

> *...Open discussions, demonstrations so that they could see experiments where the kid gets to practice. We did a lot of fun activities for the astronomy unit. They did research about different planets. They compared and contrasted the planets and figured out which one would be the best to colonize if something were to happen on earth (SW/interv1/p11/March 2000).*

Even though she used these strategies, Sarah lacked confidence in teaching science, because she was uncomfortable with her science content knowledge. In March, she said,

> *My lack of subject matter in science affects my confidence in teaching science. I can read and comprehend but to be able to teach it is what I am not comfortable with. I have not taught science enough to be comfortable with it. This is the very first time I am teaching these concepts. Because I understand certain concepts, it does not mean I know how to teach it (SW/inter1/p12/March 2000).*

The above quotation may be interpreted that Sarah believed that the more you teach science, you become comfortable and you get better at it. This notion is widely held by many teachers yet it is unproven. It will be interesting to see how Ms. Williams responded to embedded assessment given that she was aware of her instability in content knowledge and in teaching science.

An example of Sarah's teaching before embedded assessment project

Sarah: What are the 4 things that a deer needs to survive? (She asked the same question 5 times and her students regurgitated it back).

Student: Space
Another student: Why do they need space?
Teacher directed the question to the whole class
Several students' responses: So they deal with their own kind. So that they do not live at people's back yards. They need space so they have food and move around.
Teacher's response: (Role-play): Teachers stands up-front with two students to illustrate the need for space.
Teacher: What is wrong with what you are seeing, this picture?
Students: You fought over food, you are unable to produce.
Teacher: Right! There are limiting factors in the first place.
Teacher: What are limiting factors in the first place?
Teacher: These limit the survival of an animal
Student: He can kill others or they can be eaten by the wolf.
Teacher: The deer is the prey and the wolf is the predator.
Student: Some deers are dumb because when I was with my mum, they crossed the road, they did not stop even though our car was very close.
Teacher: They are not taught to respond to cars, they are just moving from one place to another.
Teacher: What can affect the deer survival?
Student: People.
Student: When I was eight years old, my mom hit and killed a baby deer (Fieldnotes/March 2000).

Analytical commentary about Sarah's teaching

From this exchange, between Sarah and her students, it is clear that Sarah's views about teaching were consistent with what she did in the classroom. She said she wanted to involve her students and in the discussion, she asked students to provide answers to her questions. Her use of the role-play in the lesson described above illustrated clearly the concepts of survival. The above lesson also showed an effort by Sarah to pose questions that students would be able to answer and if they were not able to answer, Sarah rephrased them. Her students were also bringing their experiences into her teaching. The discussion above was a fairly typical, question-response dialogue with a role-play to aid in understanding.

Students

Ms. Williams showed a concern for her students and wanted to involve all in her lessons. She described her students' profile as 'unique', because it included students from both high and very low socioeconomic backgrounds. She alluded to this when she said,

> *Our school is a unique situation because we have some of the higher social economic status and some of the very lowest. It is a very wide range of students and the same with ability range. We have very high and very low populations. You have to plan for different abilities and different backgrounds (SW/interv1/p12/March 2000).*

Sarah was aware of the challenges this mix of students presented. They came to her classroom with different backgrounds and learning styles. For example, she commented, *"its hard to get them to do their work, just to get them to class on time, to turn in their homework...it its very difficult. To have them show respect.... Sometimes I have no option but to ignore certain kinds o behavior...nothing seems to motivate them" SW/interv1p14/March 2000).* This was a common complaint for teachers in this school district and (this is based on working with teachers in various projects and professional development). When I observed Ms Williams's classroom, I got a glimpse of the kinds of behavior she had to deal with on a daily basis. For example, on March 22, Sarah spent the first twenty minutes dealing with misbehavior. They students were standing up, talking during class discussion and did not listen to Sarah. She then decided to change the sitting arrangement. Students were now sitting in rows and not in groups. Sarah believed that sitting in groups made them to socialize more and they were not having discussions that focused on science. She believed that sitting in rows helped them not to socialize but to focus on learning. One student was sent to the front office but returned the following day

for class. I was told that nothing was done to him. The misbehavior was worse than she described it in my first interview. The teacher spent most of her time dealing with the behavior problems rather than teaching science. Most of her students were disruptive to the teacher (they would talk and make noise and when she asked them to be quiet, they did not listen to her) and other students, they did not follow instructions neither did they want to do any assigned work. Some challenged her authority as a teacher:

> One *morning in April, one student was asked to come outside to the hallway because he was not doing his work and he moved from his seat and was disrupting a girl who complained to Sarah, she asked the young men to go back to his seat. But he continued and ignored her, Sarah asked him three times but the boy did not respond. She then asked him to move to the hallway; the boy walked so slowly that he took more than eight minutes. Sarah had to shout and ask the boy to hurry up, but the boy did not listen Field notes/April 2000.*

Given these circumstances that occurred almost on a daily basis, Sarah did not give up on them. I was left puzzled on what should be done to help her students. Such occurrences were hard for me and really disappointing because other students did not learn science because the teacher had to deal with disruptive behavior. Sarah was having serious classroom management problems and motivation problems such that any work to her was difficult. It was a challenge for the teacher and also the other teachers in the team.

Teacher's views on Assessment

When I asked Sarah about embedded assessment, she responded that she had never heard about it or alternative forms of assessment in the classroom. She said,

> *I could not explain to you what it means...I do not have an understanding. I have just learned the term but I use a variety of assessments. When I started teaching I used paper and pencil. And then, I learned that they were always not the best. Sometimes we do oral assessments. If they write me a letter to tell me what they have learned, I could use that as an assessment... So I have a variety of different*

types of assessment. Those people who are afraid of taking a test won't have a problem (SW/interv1/p8/March 2000).

Although Sarah had not heard the phrase 'embedded assessment', her description fitted loosely with some parts of embedded assessment, e.g., using oral assessment and writing a letter to show what students have learned. These fitted with embedded assessment because as I have discussed in chapter one, assessment can be done through oral discussion or informally and writing a letter showed the teacher what they had learned. But Sarah did not say anything about the link between these assessments and her teaching.

Planning and Reflection

Sarah used the curriculum guide to check for the goals and planned around those. Because she worked with a team of three teachers, they came early to school in the morning around 7a.m. to plan for the day. They also discussed any student concerns. They had meetings with the entire seventh grade teachers once a week, and planned for the week.

I look at the curriculum guide, and I see what the goals are. The curriculum guide, and I just go by those and plan around those...we meet first thing in the morning, and we discuss that is going on for that day. We discuss and student concern that we may have. Sometimes we have period meetings. Once a month we meet with all seventh grade teachers so we may know what is going on in their classrooms (SW/interv1/p7/March 2000).

There was a concept of 'teaming' in Sarah's school and it seemed to be well structured for teacher collaboration and also it provided teachers with a platform for having conversations among each other. This is not common in most middle schools. Even at this school, Lisa was in a team with a different structure that did not seem to work well. Sarah believed that teaming and collaboration was a good idea but people who

compose that team complicate it because people are by nature complex. She reported that the success of any team will depend on the people who make up the team. Sarah, also reported that their team reflection was done when they meet together but as for her she was consistently thinking about her science teaching.

So far, I have discussed Sarah's point of views about teaching, assessment, students and planning & reflection prior to learning about embedded assessment. So what kind of teacher was she? Sarah was a teacher with a lot of experience in teaching social studies but not science. She was not confident about science content knowledge and teaching. She had a different context, which influenced what she did in her classroom because her team planned together on a daily basis. Most of her views and her observed classroom practice suggested that she did not use assessments to diagnose students' understanding of scientific concepts and using that information to change her teaching. Sarah was bold in that she volunteered to teach science for her team and to be involved in this project. She hoped the project would make her better in science teaching. But Sarah had a lot of 'special education' students in her class. Sarah's peers in the team supported her involvement in what they called the science project. She reported that they did not understand embedded assessment and this made it difficult for her even though they were supportive. She reported that both of her peers were 'scared' of science as a subject. There seem to be a science 'phobia' in her team. The next section will look at Sarah's journey in the embedded assessment project.

Sarah William's journey of the embedded assessment project

Assertion # 1 Sarah passed through phases or episodes that were marked by challenges such as mental blocks, lack of confidence with her science content knowledge, and her belief that her kids could not write.

Phase # 1 Sarah's mental block with the word 'assessment'

Sarah had a challenge in seeing embedded assessment as 'assessment'. To her, assessment meant testing that comes after she had finished teaching a unit. She described her struggle below,

> *It's a challenge for me to get out of my mindset of assessment...I do not see what I am doing as assessment. I understand there are a lot of different kinds of assessment, I am not stuck on that, when I think of assessment, I am thinking of tests...To me, assessment makes me think more of a test and that is my mindset and that's just where I am and its hard for me to say, okay, I am going to do embedded assessment because of the way my brain thinks of the word assessment (SW/interv3/p8/April 2000).*

It is common for most teachers to equate assessment with 'tests'. Sarah was no different from other teachers in that aspect. What Sarah said shows that the thinking framework about assessment has to change first before Sarah could implement embedded assessment in her classroom. If her thinking framework does not change, it will be difficult for her to do embedded assessment in her classroom. (I am wondering whether is it the thinking that has to change or it is the actions that change first or it can occur simultaneously). In Marian Jones' case it was both her thinking and actions changed at the same time, Lisa it was actions first and then thinking. Sarah's thinking interfered with her ability to do embedded assessment. One example, is a lesson I observed in April, Sarah asked the students to read Science Plus (textbook) about succession and biomes. She then asked students questions, for example,

Sarah: What kind of things do you see in the picture?
Student: I see flowers, plants, mountains and cactuses and a whole bunch of things
Class discussion about and invisible things then Sarah asked,
Sarah: Jane read ecological succession?
Sarah: But first let me find out if anyone knows what the word succession mean.
Student: Then read the answer from the book.
Sarah: I want someone to give me in his or her own words what succession means (SW/FN/April 2000)

After this lesson, I had a casual conversations with Sarah. I asked her if she had used embedded in the above discussion. She did not think she used embedded assessment. Why? Because she thought that here, she was teaching and she had to assess them after teaching because that is when she can know if they have an understanding. At this time she thought she was helping them to build an understanding. And yet I thought that she used embedded assessment because she noticed that they might not know what succession means. She also asked them to define succession in their own words, which to me indicated that she wanted to find out if they really understood and were not just spitting words. To me, it seems that in the discussion, Sarah was both teaching and assessing at the same time which informed her next move and that is embedded assessment.

Phase # 2 Due to her mental struggles about embedded assessment, Sarah felt she needed help

Sarah found planning for embedded assessment difficult. If she could not plan for it, this affected her ability to do embedded assessment in the classroom. In interview number two, Sarah said, *"I need more help with planning for embedded assessment, How*

do I decide what strategies will be best for my students? I need more instruction on how to deepen so my kids can understand"(SW/interv2/p6/March 2000).

Why was Sarah struggling in her conception of embedded assessment? My hunch is her decision to do mostly oral assessments limited her ability to examine deeply what her students wrote, so that she could plan based on what they wrote. In professional development session # three, the other teachers tried to encourage Sarah to help her students do more writing and here is what Lisa Leslie said in that session, *"Because of embedded assessment I realized how hard it was to accurately assess kids without allowing them to write down their thoughts in their own words" (PD/LL/3/p2/April 2000)*

Sarah responded to this, by saying,

> *I am comfortable with doing oral assessment because I know my student cannot write their thoughts well on paper, they are not writers. I am uncomfortable with the science content. If you are not excited about something you will not do it well. Do I like embedded assessment? No! Do I like having to do one more thing? No! Do I use it? Yes! Will I continue to use it after the project? Yes! Will I continue to plan for embedded assessment? Sometimes but not always. It will depend on the situation and how I am feeling and how the kids are getting along with it (PD/SW/p2/April 2000).*

Sarah was not going to change what she believed worked with her students, even though she was getting suggestions from other teachers about allowing her kids to write. Why was Sarah clinging to her beliefs? It seems to me that Sarah had a limited view of her students' capabilities. By saying that, her use of embedded assessment will depend on the situation and how she was feeling, brings a notion that she lacked a focus on learning and this is emerging again in the above statement. She may have been uncomfortable with the science subject matter and she thought that this would be one more thing to do. She was not excited about science and embedded assessment. This influenced what she did in her classroom and how she did it. Sarah requested help in general and yet she

rejected the help because it did not fit into her belief system about what works for her students.

On the other hand, one might argue that Sarah did not give her students opportunities to write because of the many low ability or special education students who could not write well. She may have thought that she was sparing them and herself frustration and failure.

Phase # 3 Sarah tried oral assessments

Since Sarah believed that she could not help her students with writing, she concentrated on doing more oral assessments. She described how she did oral assessments as follows: *"I like to sit on the desk and do quick checks with people. Okay, tell me about this? Give me the sense you are making of this? I do group discussions and I ask a lot of questions. When we read I stop and ask tones of oral questions" (SW/interv5/p4/May 2000).* Sarah continued to use embedded assessment for assessing orally. But she did not write down what her students said. This may be the reason why she found planning for embedded assessment hard because she could not remember everything her students said so as to adjust instruction. For example, in the section below Sarah asked students about graphing.

First, there was a discussion about what they did the previous day. Students made a line graph using the data from the previous day.
Teacher: What is a line graph?
Student: It's like what we did yesterday.
Teacher: What happened to your deer population?
Student: It decreased.
Teacher: Why?
Student: There are many factors, like people kill it. We have some neighbors who do deer hunting every year and they kill the dears.
Teacher: I want to know what happened at each point in the graph?
Student: There are some places where there might be no food for the deer and the population goes down.

Teacher: What do you think will happen to the population of deer over several years? Student: It will go up and down (Fieldnotes/April 2000).

This example of her oral assessments highlights the students' role to answer the teacher's questions. Their answers left some doubt as to whether they really understood the key ideas. The students did a good job of bringing in their outside experiences but making connections to what they were learning was the missing piece. The bringing in of their experiences resembled story telling more than assessment.

Phase # number 4 Sarah believed she overcame her challenges

In interview number five; Sarah reported that she had overcome her challenges. *"Well now, there aren't a lot of problems and challenges because now I think I have grasped the concept. I have put my test word behind me. It is easier to plan and see where I am using it" (SW/interv5/p16/May 2000).* I asked Sarah about what made a difference for her; she was not able to explain. But my hunch is that the professional development meetings were influential if the change was made. I am not confident enough that she changed much. I think her weakness in the subject matter knowledge and a limited view of her students' capabilities contributed to this. The evidence is that she did not change her stance on allowing students writing opportunities. She was not the same as we started the project. Why? Because now, she was listening carefully to check for her student's understanding in their talk. Her students seemed to enjoy some of the teaching strategies. For example, in May, I wrote the following reflections about Sarah:

> *Sarah brings in her experiences from teaching elementary grades to her science teaching. She uses role-plays to explain concepts. When the teacher tried to use embedded assessment the students were less disruptive. She had to sit down and monitor learning instead of monitoring behavior as students were engaged in doing*

their work. This is what normally happens in Sarah's class since learning about embedded assessment:

- *She posed questions and rephrases them*
- *She used a lot of role playing strategies*
- *It was taking very long for Sarah to teach a concept (Field notes/ May 2000).*

This shows that there was increased engagement of students and a decline in disruptive behavior was noted. One factor that might have contributed was the use of role-plays that engaged students and may have increased their interest in science.

Summary of Sarah William's journey in the embedded assessment project

Sarah a 7th grade social studies teacher was asked to teach science because she had a minor in elementary science. She decided to participate in the embedded assessment project to improve her science teaching. Sarah passed though phases or episodes in the embedded assessment project that were marked by challenges such as struggles with the word 'assessment', her weak science content knowledge and her beliefs that her kids could not write. Sarah equated the word 'assessment' with tests. Sarah's thinking about 'assessment' as tests limited her ability to do embedded assessment. It seemed to me that Sarah's struggle in this project was linked to her beliefs about her students, learning and assessment.

Sarah found planning for embedded assessment difficult and this limited her ability to do embedded assessment in the classroom. Sarah did not require her students to write because her goals were to make them survive school. I think her problem with embedded assessment was also due to her beliefs about her students. It may be difficult to plan for embedded assessment if you do not allow your students to write. Even though other teachers tried to persuade Sarah to write she stuck to her beliefs and plans. A third

of Sarah's class were special education students. Many of those students may not write well. She may have thought she was sparing them and herself frustration and failure. But this brings to me the idea of teaching science to all. If we accept Sarah's stance, this challenges the science education reforms. What is being scientific literate for special education? Does the phrase science for all exclude the special education students? In my understanding, scientific literacy goals are for everyone. But is this a realistic goal given what we are seeing in Sarah's class? It was also my assumption that embedded assessment should help teachers identify their students' difficulties so they can help them. Sarah was aware of her students' weakness but rather chose not to focus on that. Instead she chose to use oral assessments. So, for Sarah even though she struggled with the word 'assessment' she used oral assessments.

Assertion # 2

Embedded assessment took the form of oral assessments in Sarah William's classroom

Sarah believed that she could not help her students with writing, she therefore concentrated on doing oral assessments. She used classroom discussions, group work and individual questions, which she called 'quick checks'. An example from Sarah's class is when she noticed that some of her students did not understand what the deer needs to survive. She asked this question more than 5 times with no response from students. The teacher then designed a role-play. It involved the teacher standing up front with two students to illustrate the need for space, food and reproduction. Sarah and the two students up-front fought over food and space. After the role-play the students could easily answer her questions: What does a deer need to survive? This role-play shaped the

conversation that followed. The students then talked about the deer killing animals for food and survival. The teacher then introduced the concept of predator and prey. The example given above shows how the classroom climate changed when the teacher adjusted her instruction in response to students. The interaction between Sarah and her students was shaped by students' reactions and their ideas. It seemed to me that Sarah, like the Lisa in the study was redefining embedded assessment. She was using it in a way that fitted her context and her students.

As a researcher and a participant observer in Sarah's class, I was left puzzled with Sarah's stance on writing. We will later visit this issue when we discuss the cross case analysis. Now I will turn to how embedded assessment influenced Sarah and her classroom environment.

Assertion # 3 Embedded assessment had a slight impact on Sarah Williams

In the following section, I will discuss the minimal influence of embedded assessment on Sarah Williams' teaching, planning and students.

a) Impact on her teaching

Sarah reported that embedded assessment made her realize that her teaching methods were not working and what she needed to do better. She said,

> *Embedded assessment makes us realize what we have to do better and gives us a means to assess student without paper or pencil.... I gave up on writing...Embedded assessment makes you start from where their inabilities are, and move forward. We are stuck, given certain parameters: if we have a child that is below certain parameters, that means we cannot start where we are supposed to start. Everybody is running a race and we are way behind the starting line. Because of embedded assessment we now know that our kids are way below the starting line of the race and how are we supposed to win the race (SW/p5/interv4/April 2000).*

Here, Sarah appeared to contradict herself. She realized that her students could not write well and she believed that embedded assessment made her to realize what she needed to do better. Yet, what she needed to do was to help her students write, she gave up on that because she thought that they were too behind. She recognized that they were going to move to the next grade and still not have those skills. By reporting that her students were 'below the starting line of the race and how are we supposed to win the race', brings the notion that Sarah might have had low expectations for her students. It may be that the impact here consisted of her realization that her methods of teaching were not working and her starting to think what would be possible to do, given the type of students she had. She said,

> *We have to come up with a way to teach these kids because what we have is not working. It's very frustrating. My methods of teaching are not what they need to learn. They need something else that I have not been taught yet. We now have a different breed of students and we have to teach them differently, and probably in a discovery type of situation, they will do better. In this technological age, we need to use technology constantly in the classrooms, interactive technology...we need to find a way to get the attention of the students. We should make our own Pokemon cards with all the information they need to know. Kids need something entertaining like the Magic School bus and Bill Nye the Science Guy. They know and remember what he says because it is entertaining (SW/interv4/p3/April 2000).*

Embedded assessment project, enabled Sarah to rethink deeply about her methods of teaching (in the above statement she said 'my methods of teaching are not what they need to learn). She was evaluating her pedagogical approaches because she recognized that change was needed (because earlier on she said embedded assessment helped her to realize what she needed to do better, she also said she needed to reach the different breed of students). She proposed one aspect of that change was to seek the attention of students by looking for ways that entertain and teach at the same time. However, Sarah considered

that approach not feasible, considering the present school system and the availability of the technology. I concur with Sarah that teachers need to find ways to get at student attention especially in her class where there were special education students and many behavior problems.

Sarah believed that the project had enhanced her thinking about teaching.

> *I am leaning a lot of information and I am thankful that I was introduced to this. I was now focusing on helping my student understand key concepts in the ecosystem unit. I wanted them to know how ecosystem work, what is an ecosystem and the relationships in the ecosystem (SW/interc3/April 2000).*

Embedded assessment did not have a strong influence on Sarah Williams. However, it influenced her to focus on the big ideas in the scientific content. It influenced her practice in that she was re-teaching so that her students will grasp the key ideas. For example, she said,

> *I am re-teaching a lot more and doing embedded assessment a lot more frequently, at least noticing that I am doing it a lot more frequently. But definitely, re-teaching is something I am doing and I enjoy that. Before this project, the way I re taught, If I were to explain something, I would explain it again the same exact way. The odds were the student would not understand because the difference was in the tone of my voice and the speed of my speech. I would change the tone of my voice or I spoke quieter or faster or louder. That does not help I need to explain in a different way (SW/interv5/p3/May 2000).*

Sarah was able to reflect on what she used to do and contrast it to her current practices. Her description of how she originally re-taught is typical in most classrooms. Embedded assessment helped Sarah realize that this did not help her students to understand. Rather, it was merely a waste of her time and the students' time.

b.) Impact on planning

Embedded assessment influenced Sarah to plan for daily lessons instead of just planning for the week. Although she planned daily with her team, this planning was not focused on the details of teaching science. She was now more flexible in her planning than before where she followed exactly what she was supposed to do regardless of how her students responded. She alluded to this, when she said,

> *I planned for the whole week and I stuck to my plans. But now I also plan on daily basis but also having an idea of where they are going. I deepen the lesson instead of mobbing on to something else. You have to play with it because they are getting it or they are not getting it (SW/interv6/p13/JUNE 2000).*

Her planning was also influenced by her limited content knowledge.

c.) Impact on students

Sarah believed that embedded assessment was having an impact on her students because when she they did a poster, they were proud of their work and enjoyed learning. She said, " *I think that making a poster is so much easier for them than writing a paper. They enjoy their work, seeing it look better. They are proud of their artwork. They critiqued each other's artwork". (SW/interv 3/p3/April 2000)*

This statement is consistent with what has been discussed above so far. Her belief that her student are not good writers and therefore she did not ask them to write anything throughout this project. Instead they drew posters and explained to her the ecosystem that was presented in the poster. She reported that her student were proud of their work.

Embedded assessment had a minimal influence on Sarah Williams. Why do I say minimal? This will be clear when I do the cross case analysis of the three teachers in the project. Sarah had challenges that related to her beliefs, her content knowledge and her

context. She worked, and planned lessons with, other teachers who were not involved in the project. She had challenged with her science content knowledge, which is critical for doing embedded assessment well.

Summary of the impact of embedded assessment on Sarah Williams and her classroom environment

I have asserted that embedded assessment had a slight impact on Sarah Williams and her classroom. Sarah in interview number four, reported that embedded assessment made her realize:

- What she needed to do better
- That her methods of teaching were not working and given the profile of her students she was in search for better ways.

She reported that those ways should reflect what is going on in the society. The young people are being entertained and school needs to be entertaining as well so as to get their attention. Sarah believed that embedded assessment had enhanced her thinking about teaching. She reported that embedded assessment made her to focus on understanding of concepts. It made her to re-teach concepts that she thought were not understood.

Why did I assert that embedded assessment had a slight impact or influence? Because even though Sarah used embedded assessment to find what she needed to do better, she continued in her old ways of thinking about her students. As I have already discussed, she thought her students couldn't write and she did not help them with writing

skills. Though some of her oral discussions were quite lively and engaging for students, I think that the impact or influence would have been much stronger if she had tried to help her students with writing. On the other hand, I think that Sarah and her students benefited from participating in this project because the interactions in the classroom changed. Sarah and her students were interacting about scientific ideas and also students were bringing in their life stories. This might mean that they were connecting science to their everyday lives although it was hard to prove that. Students interacted about their ideas and science. The discourses in Sarah's classroom were not her telling them the correct way or correct words. Instead it was Sarah who was questioning her students so that they reconstruct their understanding based on the scientific ideas they were learning. Embedded assessment helped Sarah to reflect about education in general and her methods of teaching. Even though Sarah did not change much in her practice but she had started thinking deeply about what it means to teach effectively and in general. Sarah was reflecting on why students were not willing to engage in school. Her answer was that because school as it is, is not entertaining.

Sarah was beginning to think about the issues of making schools exciting for young people. If it were not for involvement in this project, Sarah would not have thought about these issues. Sarah proposed that because the society is heavily influenced by technology, it is time to involve more technology in the classroom. She also, questioned the feasibility of her suggestions.

Assertion # 4

In the process of learning about and using embedded assessment Sarah faced problems and challenges.

Sarah is a social studies teacher who was asked to teach science. She participated in this study because my original teacher dropped because of cancer related sicknesses. So, I asked her to participate in the study because I could not get anybody to replace the other teacher (I talk about this in my methods chapter). This context is in itself problematic for embedded assessment because of lack of science content knowledge.

Sarah was also part of a team that although they said they were supportive of her involvement in the project, they kept her from focusing on embedded assessment. Sarah had a third of her students as special education students and she had already stereotyped them that they could not write and therefore did not provide opportunities for them to write. What about the 2/3 of her students who were not special education? Were they not being shortchanged by the circumstances in her class? When I asked this to Sarah, she replied that her major goal was to help them survive school. Sarah had some management problems in my observation notes I wrote the following reflections after two weeks in her classroom:

> *The teacher faces behavior problems even though there is always one teacher who helps. The teacher spends more time dealing with disruptive behavior. I checked my watch today it was almost a frequency of every other 2 minutes. Sarah talked to me after class about her lack of confidence about science content knowledge. She said that some of her students were aware of this and doubted the credibility of the information given (FN/p16 March 2000).*

This context makes the case of Sarah an interesting comparison case and a difficult case at the same time. It is difficult for a teacher without content knowledge to do embedded assessment. Sarah was aware that this was a limiting factor for her. Sarah had difficulties with analyzing the content or ideas that her students were giving her. This made it difficult for Sarah to do embedded assessment.

Another problematic area was her beliefs about her students. Sarah had deep ingrained beliefs that her students could not write and she was not going to help them with writing. Instead most of her assessments were oral. Sarah complained about time, students and the school system.

Summary of the Sarah Williams Case

The making sense of embedded assessment was in stages for Sarah Williams. Embedded assessment took the informal oral assessments only in her classroom. This project had a minimal influence on Sarah Williams because of her weak content knowledge and her limited view of her students' capabilities. However, Sarah's classroom environment had slightly changed. Sarah focused less on managing behavior and concentrated on managing learning of scientific ideas. Sarah faced problems with time and the system of schooling that limited her ability to do embedded assessment.

CHAPTER 7

CROSS CASE ANALYSIS

In chapter 4, 5 and 6 data from each teacher was presented in the form of themes and assertions emerging from consistent patterns in the data. In this chapter, I focus on the cross case analysis. I will present a cross case analysis by organizing it around four research questions:

1. How do middle school science teachers make sense of the idea of embedded assessment?

2. How do middle school science teachers use embedded assessment in their classrooms?

3. What impact does embedded assessment have on teachers?

4. What are the obstacles/challenges/problems/tensions/struggles teachers face as they learn about and use embedded assessment?

1. Comparison of how the three teachers made sense of embedded assessment

In this section I discuss ways in which the teachers made sense of embedded assessment were similar and different.

What was similar? Assertion # 1: The three teachers passed through stages or phases in their involvement with the embedded assessment project

Data has indicated that the way all three teachers made sense of embedded assessment was in stages. Assertion number one in chapter 4, 5 and 6 indicated that all three teachers passed through phases in their involvement with the embedded assessment project. These stages were marked by adjustments in their thinking or in their practice or both. The way

each teacher made sense of embedded assessment emerged from their beliefs about students, teaching, learning and assessment, and the teacher's analysis of what was practical given the context of use. By this, I mean the teacher analyzed what will work for her given her type of students and the school system in which she was working. Marian's understanding of embedded assessment reached complexity and was similar to the researcher's original intention. Towards the end of the study, Lisa tried some embedded assessment and later developed her own way of doing embedded assessment, for difficult concepts only. Sarah decided to do oral assessments only because she believed that her students lacked writing skills. In general, the pattern for all the teachers was one of back and forth trying out, then reflecting and then modifying teaching.

All the three teachers reported that embedded assessment was difficult and challenging for them and their students. It required teachers and students to have new skills. For example, it required teachers to analyze students' work or words to search for meaning, misconceptions and adjust their instructions. Teachers had not done this before and they had not seen anyone doing it. Embedded assessment required students to be active participants in the classroom. It required them to show their thinking and not what was in the book, which was different from what they were used to. This required a change in the culture of the classroom and this posed difficulties as the classroom culture was already established when this project started in the middle of the school year. One teacher complained about the timing of this project and compared it to changing the rules in the middle of the game. Teachers reported that the timing made it even difficult for them to do embedded assessment. The students were also resistant to these sudden

changes making it harder for the teachers.

Teachers either questioned or doubted or rejected the ideas of embedded assessment. When Marian tried some embedded assessment, she started questioning a lot of things, for example, how to plan for embedded assessment and how to adjust instruction. She said embedded assessment, in the way it was described in the professional development sessions was too general. It did not provide her with minute-to-minute practice. Marian doubted if she really understood embedded assessment. On the other hand, Lisa rejected embedded assessment and did not put into practice some of the ideas, because she thought they were not practical. Sarah on the other hand complained that the word 'assessment' was blocking her conception of embedded assessment. What was similar about these teachers is that they passed thorough zones of uncertainty and doubted about this approach of assessment.

What is similar, too, is that even though embedded was hard and difficult for the three teachers, they did not completely reject it and give up. The teachers reported that it made a difference in their classrooms. The support that teachers had from the professional development sessions and my classroom observations and conversations made a difference in the outcome of this project. I had casual conversations with the teachers before or after the lessons. The teachers reported that having another knowledgeable adult in the classroom was helpful. In the professional development meetings, teachers would discuss some of their challenges and brainstorm possible alternatives that could address the problem. They also exchanged ideas about what they were doing that they could call 'embedded assessment'. For example, in one of the

meetings, Marian reported that she was not aware of what she was doing that was embedded assessment. The teachers decided to do a lesson plan together, focusing on the use of embedded assessment. They tried it with their students. In the next professional development session, they talked about how the lesson turned out in their classroom. This helped Marian with her questions and in understanding embedded assessment.

In one of the professional development meetings, Sarah brought the idea that she could not bring any student work to the meetings because her students were not writers. She did not give written tasks. The teachers brainstormed ideas about how writing is essential and important part of learning. Unfortunately, Sarah did not change her stance.

To summarize, the similarities among the three teachers about how they made sense of embedded assessment lie in the fact that they all passed though stages that were marked by problems and anxiety. They all believed that embedded assessment was hard and challenging for them and their students. They all thought embedded assessment was beneficial and they valued the professional development sessions as a support system for them.

What was different about the way teachers made sense of embedded assessment?

Although teachers passed through phases in the embedded assessment project, the stages were different from teacher to teacher. For Marian, the stages were: she started the project understanding its underlying principles. This was followed by doubt and questions after trying it in the classroom. This made her to doubt if she really understood embedded assessment. The final stage was when Marian was comfortable in her understanding of embedded assessment. For Lisa, the stages were: she started by partially

rejecting the theory of embedded assessment because she questioned the feasibility of embedded assessment within the school system. This was followed by an 'aha' experience which marked her turning point in the project. For Sarah, the stages were: she started by having a difficult time with the word 'assessment'. This word presented a mental block for her because to her, assessment was testing that occurs after she has taught a unit. The second phase was that, due to her mental struggles about embedded assessment, Sarah felt she needed help. This was followed by Sarah trying oral embedded assessment in her classroom. The last stage was that Sarah believed she had overcome her challenges.

One of the reasons for the differences in the stages was that the teachers started this project at different stages of their careers. Marian, a beginning teacher, readily embraced the ideas of the embedded assessment project because they fit into her beliefs about teaching, learning and assessment. Marian had attended a teacher preparation program that pushed ideas about teaching for understanding and using assessment to guide instruction. Therefore, Marian was headed in the right direction from the start of the project. Lisa, a veteran teacher, thought that this would not work given the conditions of her work place. She did not start enthusiastically about the project and it was not until two months into the project that Lisa tried to use embedded assessment systematically. My interactions with her caused this to happen; otherwise things would have continued the same in her classroom. The other difference was in terms of my interaction with the teachers. Marian scheduled my classroom observations such that after her lesson we would have time to talk and reflect on what happened. Lisa and Sarah's teaching

schedules did not allow that to happen because they both had planning hour the first thing in the morning.

Another difference is what the teachers decided to focus on in the project. Embedded assessment has many components as discussed in chapter one. It includes gathering information, analyzing information, giving feedback and adjusting instruction. It can be done orally or in writing or drawing tasks. Marian used all the different forms of embedded assessment. This led to an in-depth conception of embedded assessment and an increased impact on her thinking and practice. She started using embedded assessment systematically right from the start of the project, even though she faced challenges and problems. Lisa started to use embedded assessment systematically two months after the project had started. Why did Lisa start to use embedded assessment after two months? She was using it sporadically and using some components but not all. Her rationale was that the logistics of doing embedded assessment were next to impossible. Lisa saw the system in which she was working as an impediment in trying embedded assessment. Some examples that Lisa mentioned are class size and the curriculum. She believed that it was impossible to address all her students' misconceptions or difficulties. The other aspect was the idea of placing less emphasis on grades. Lisa believed that giving grades was important for her, the students, the principal, the parents and the district. What made Lisa change her conceptualization of embedded assessment?

Lisa felt that she was stuck in a system that inhibited her ability to do embedded assessment. She reverted to her old ways of doing things. At this time, I intervened by asking her to use different types of questions. This led to her breakthrough. In analyzing

students' work, Lisa realized that her students had poor writing skills. Lisa started talking about her realizations after the analysis. In her own words she said,

> *You started realizing that what you thought they knew and what you thought they learned, they might have just been guessing. They might not have really learned it that it was reading something and recognizing a word in the answer that made them choose that. But if you use embedded assessment accurately, you need to see them write something that comes from their own knowledge, from their own internal ideas and so you use open-ended responses rather than multiple-choice tests or fill in the blanks. The results are so vastly different such that I did not know if they learned anything the entire school year because that is what I used most of the time. This was very depressing for me and I stopped because I could not handle the thought of wasting my time and kids time all these years they have sat in my classroom (LL/interv 4/p43/April 2000).*

Worksheets are easy to handle and they are faster to grade, compared to open-ended assessments. But Lisa was starting to recognize that they did not tell her much about her students' learning. Through using embedded assessment, Lisa discovered that students were lacking basic skills like writing and she decided to focus on that. This experience caused Lisa to have a positive attitude about embedded assessment. She was now willing to do more embedded assessment because it gave her evidence of her kids' learning. After my intervention, Lisa thought about ways of dealing with constraints. Then she decided to use embedded assessment for difficult concepts only. This was problematic because it compromised the key aspect of embedded assessment, i.e, the continuous and ongoing nature of embedded assessment. This made me realize that embedded assessment cannot be described in a mechanistic fashion. Lisa conceptualized embedded assessment in her specific context of use, in the classroom. This for me raises issues: is Lisa's conceptualization in the understanding of what it means or is it in the

use? It seems to me that both what happened in her mind and how she used it are important and the sum total of the two represents her conceptualization of embedded assessment. So, how do I define Lisa's conceptualization of embedded assessment? It is consistent with the embedded assessment framework but different in the timing of use. She used it when she knew that students would have difficulties for a particular concept. This, in a way, is redefining embedded assessment.

Sarah decided to focus on oral assessments, because she believed that her students could not write. She reported that her goal was not to help them with writing, but to equip them with survival skills for school. Even though in the professional development meetings, other teachers tried to persuade Sarah to give written tasks, she did not change her stance. A third of Sarah's class were identified as needing special. Many of the special education may not write well. She may have thought that she was sparing them and herself frustration and failure. Another difference between Sarah and the other teachers is that Sarah struggled with the word 'assessment. To her, assessment meant testing. Sarah's thinking about 'assessment' as tests interfered with her ability to do embedded assessment and her making sense of it.

I have discussed the similarities and differences of the three teachers in terms of the way they made sense of embedded assessment. We have seen that the differences were in the teacher's beliefs about assessment and in what happened when the teachers used embedded assessment in the classroom. Now, I will turn to address research question number two, i.e., how does embedded assessment look in practice in middle school science classrooms?

Comparison of how embedded assessment looked like in the three classrooms

What was similar?

The similarity among the three teachers was that their classrooms looked different compared to the time I started observing. The classroom interactions, discourse, classroom climate, and student engagement with scientific ideas had changed. There was more interaction between teachers and students and among students. The focus of interaction was based on students' ideas about how they were making sense of the material they were learning. There was more interaction about varied understandings of scientific concepts. But how they structured these interactions differed from teacher to teacher.

The discourse changed as teachers required students to give details of their thoughts about scientific phenomena. The discourse changed from one word textbook answers to more elaborate answers that exposed students' reasoning. This was also due to the type of questions asked by the teachers. Marian referred to as, asking 'learning or thinking questions'. This was a shift from focusing on memorizing factual information to focusing on students' understanding of science. The discourse was not focused on the teacher lecturing or telling the correct information or correct words to say. Instead it was guiding students in reconstructing their understandings based on new information and experiences. All three teachers used group presentations in one or more lessons. This enabled other students to listen and contribute to each other's work by analyzing it. This environment allowed students to collaboratively share their work with peers.

All the three teachers used embedded assessment to investigate their students' ideas through an open-ended exploration, discussion or brainstorming sessions. They were also analyzing their students' work and they were designing instructional strategies.

What was different? Assertion # 2 Embedded assessment took many shapes and forms in Marian's classroom compared to other teachers

Marian embraced this project with open hands from the start. In her classroom, I observed many shapes and forms of embedded assessment. By shape, I mean the assessment/teaching strategies, and by form I mean was the task oral, written or drawn. Marian used the following assessment strategies: classroom discussions, group presentations, role-plays, drawings, concept maps, peer reviews/analysis, journals writings and poster presentations. Embedded assessment in Marian's classroom was characterized by the intentional design of different types of activities so that she could collect information on students' understanding. Marian was thus becoming an investigator of her students' reasoning about scientific ideas. Marian used different types of teaching/assessment strategies because she thought that it helped to address all kinds of learners in her classroom. It also helped her to discover what kind of strategies her students preferred and which ones were suitable for each class.

So, how did Marian sequence instruction in a way that was different from other teachers? What moves did she make that were different from the other teachers? The difference between Marian and other teachers is that Marian systematically used

embedded assessment from the start of the project. She structured all her lessons based on the information she got from students or based on previous occurrences in her classroom. Marian did not give up on using embedded assessment because of the challenges that appeared. Her instruction was sequenced in a way that she would be able to obtain information from her students about their reasoning. She used that information to analyze students' thinking and to design instructional strategies. Marian structured her lesson in a way that the cyclical nature of embedded assessment became visible. Marian faced problems. She was not skillful at analyzing the information she got from students. She faced challenges with some of the peer analysis strategy. She reported that she needed to learn effective ways of doing peer analysis. Even though Marian witnessed some failure of some of the teaching and assessment strategies, she thought that embedded assessment had transformed her classroom because she was getting more from kids. They were participating more in class and the quality of their assignments had changed. It was no longer words taken from a textbook but how the kid/student was making sense of the information. This gave Marian more informed knowledge about her kids' thinking and how to push them further in their understandings.

On the other hand, Lisa took a long time after the introduction of embedded assessment to try the complete cycle of embedded assessment because she had partly rejected it. She also took some time dealing with helping kids with their writing skills. She helped her students to write to express their ideas. She modeled what it is like to state your ideas. For example, she discussed examples between fact and opinion. She asked the question; "where does Lansing get its water?" A student responded, "From the wells".

Lisa then stated that: *"it comes from the wells and* it *is purified to kill germs and take out some chemicals" (FN/p8/April 2000).* This was an example of a fact with some explanation.

For Lisa's case, embedded assessment started with her giving feedback that was different from before she learned embedded assessment. I think she did this because it was easy for her and it did not slow her down. Her students were asked to respond to the feedback at home. This did not take much from her instructional time but it took a long time to do. Although I could not see something that is out of the ordinary in Lisa's class, assessment was taking place. Students worked to critique one another's work; they had debates and made presentations. In the process of using embedded assessment, Lisa was interested in the students' ideas and how to state them on paper. The difference between Lisa and the other teachers is that the way embedded assessment looked was influenced by when she started to use it systematically. It was a long time after the project had started and therefore, I did not have the opportunity to observe many instances as in Marian's case. Embedded assessment in Lisa's classroom took the form of helping her kids to write to express scientific ideas and their thinking. Her students were not familiar with this; so embedded assessment took the form of Lisa modeling to her students what it means to write a sentence to show what you are thinking and to express your ideas. Lisa readily embraced the idea of giving feedback in a different way than her kids were used to (because her kids were used to being given feedback in the form of grades). But now her feedback was in the form of questions that required students to rewrite and answer specific questions that were grounded in scientific concepts.

Sarah believed that she could not help her students with writing; she therefore concentrated on doing oral assessments. She used classroom discussions, group work and individual questions that she called 'quick checks'. This involved Sarah noticing, recognizing and responding to student thinking during interactions. An example from Sarah's class is when she noticed that some of her students did not understand what a deer needs to survive. She asked this question more than *five* times with no response from students. Sarah then designed a role-play. It involved the teacher standing up front with two students to illustrate the need for space, food and reproduction. Sarah and the two students up front fought over food and space. After the role-play, the students could easily answer the question: What does a deer need to survive? This role-play shaped the conversation that followed. The students then talked about the deer killing animals for food and survival. The teacher then introduced the concept of predator and prey. The example given above shows how the classroom climate changed and how the teacher adjusted her instruction in response to students. The interaction between Sarah and her students was shaped by students' reactions and their ideas. It seems to me that Sarah like Lisa was redefining embedded assessment. She was using it in a way that fit her context and what she considered appropriate for the type of students in her classroom.

To summarize, embedded assessment took many forms and shapes in Marian's classroom. In Lisa's classroom, embedded assessment started as little piece-meals of feedback and moved to helping with writing skills. In Sarah's classroom, embedded assessment was oral throughout the project. However, there were similarities in how

embedded assessment looked in the three classrooms. Teachers were *investigating and gathering* a collection of students' ideas and reasoning. The teachers were *analyzing* the information and using the information to *design* their next moves. The problem with this was that it was difficult to see, because sometimes it was happening in the teacher's mind. I was able to figure this out by asking the teachers during my interviews. Sometimes, teachers themselves were not aware that they were doing embedded assessment. But once they became accustomed to it, it was easier to talk about what was happening in their classrooms. Although there were subtle differences in the way embedded assessment looked in the three classrooms, the change in all three classrooms was noticeable.

Comparison of the impact of embedded assessment

Assertion # 3: Embedded assessment influenced the teachers' perspectives about curriculum, students, teaching, assessment and planning and reflection even though this was different from teacher to teacher

In this section I will discuss the similarities and differences on how embedded assessment influenced the teacher's perspective about 1) the curriculum 2) the students 3) teaching 4) assessment and 5) planning and reflection. I will end with a summary of the comparison.

Table 7.1 Impact of embedded assessment on Marian, Lisa and Sarah

Teacher's perspective on:	Marian	Lisa	Sarah
Curriculum	• Focused on key ideas • Packaging her curriculum with her students in mind	• Curriculum needs to be covered	• Curriculum needs to be covered
Students	• Students talked more about science and shared ideas. Marian believed that talk revealed their thinking, understandings, confusions and misconceptions • Marian saw a connection between E.A. and talking • Marian listened to students, not to evaluate right or wrong, but to gauge scientific reasoning • Marian believed that talking and listening to student talk helps with value, self esteem, participation and behavior	• A shift from teacher centered classroom to student centered classroom • Students doing more activities, talked more about science among each other • Lisa focused on writing to learn instead of writing to be evaluated	• Students can not write • Classroom interactions changed • Students interacting about scientific ideas • Students were bringing in their life experiences in science lessons • Students reconstructing their understandings based on the scientific ideas they were learning

	• Student talk sparked ideas about instructional moves • Classroom interactions changed • Classroom discourse changed		
Teaching	• Embedded assessment helped Marian achieve her goal to teach for understanding • Marian was questioning for understanding • Marian saw a connection between embedded assessment and teaching for understanding	• Lisa tried 'new' teaching / assessment strategies • Embedded assessment became a tool that helped Lisa to identify that her students lacked certain skills (writing) and to teach for understanding	• Sarah used E.A. to focus on understanding of concepts • It made her re-teach concepts that were not understood • Lively oral discussions • Designed activities that engaged students
Assessment	• Marian focused less on grades • Marian did planned embedded assessment as well as interactive embedded assessment daily • Assessment was ongoing and integrated with teaching	• Lisa focused on writing to learn, writing to express thinking and state scientific ideas clearly • Lisa gave constructive feedback • Lisa re-taught concepts that were not completely understood	• Sarah focused on interactive embedded assessment only • Sarah did oral assessments • Students were not given opportunities to write but to talk and express their thinking

Planning	• Planned daily and in the moment of teaching • Considered evidence that will show students have learned for each day • Planning was based on previous happenings in class	• Lisa connected lessons together and based her planning on classroom occurrences • Lisa used student work as a guide to choose instructional strategies • Embedded assessment gave Lisa a systematic tool for planning based on evidence from students' work	• Did team planning daily this did not involve E.A. • Planned in the moment of teaching • Gave considerable considerations on the kind of questions she will ask
Reflection	• Reflection done daily • It focused on teaching & learning of scientific concepts • Reflection became more precise	• Based her reflection on classroom occurrences	• Sarah reflected generally about education and why kids were not excited about school • Reflection was less precise

From the above table we can see that although teachers had similar professional development sessions, how the project influenced them was different, even though there were some similarities in certain issues. I will first discuss the curriculum.

The three teachers were from the same district and therefore they had the same curriculum guidelines. Marian searched for key ideas for each district objective. Marian did not have difficulties with stating key ideas because her teacher preparation program had prepared her in that aspect. Marian was not only considering the given district curriculum guideline but she was readapting that curriculum to suit her students' needs. By this, I mean that Marian was considering what do my students know and what is it that they do not know instead of just covering the curriculum. For Lisa, covering the curriculum was important because she believed that she was accountable for that. Sarah covered the curriculum but did not see this as important. It seems to me that Marian had the greatest impact with regards to the curriculum and embedded assessment project. Key ideas are important for the embedded assessment framework because they help the teacher to assess the understanding of those key ideas.

Impact of embedded assessment on teacher's perspectives about students

If I exclude Sarah's views about her students' writing, all the points mentioned by teachers are related to constructivism (see table 7.1). To me, this brings about the connection between embedded assessment and constructivism. You cannot teach didactical when using embedded assessment because students have to talk and show how they are making sense of the scientific ideas. The impact of embedded assessment on teacher's perspective about students is that it enabled the teachers to come up with teaching strategies that allowed students to learn in a constructivist manner. Because of this I have developed a three part conceptual model that highlight the interrelatedness of

embedded assessment, constructivism and the science education goals of teaching for understanding and science for all (see chapter 9). In this model I argue that changes in assessment approaches as we have seen from the three teachers, required changes in teacher's conception of how students learn. I also see that the teachers in my study alluded to the point that embedded assessment allowed them to teach for understanding. Teaching for understanding is a goal for the contemporary reform efforts as well as the goal of science for all. *All the three teachers reported that embedded assessment allowed them to teach for understanding and thereby reaching far much more students* because they were helping them with their difficulties. I see a relationship developing between embedded assessment, goals of the contemporary reforms of science (teaching for understanding & science for all) and constructivism. The diagram (in chapter 9) shows interlocking circles meaning that there is coherence and interrelatedness of the three constructs. To extend, I see also a relationship between old views about how people learn and the traditional forms of assessment. Learning was seen as knowledge acquisition and assessment as tests and the goals of science education was that science was not for all it was for the privileged few who could compete with Russia for scientific superiority (Bybee, 1997).

In this new century, these goals have changed to producing a scientific literate citizenry. So, our methods of teaching, views about how people learn and the model produced here seem to make sense to me. While it is not completely based on the data obtained it evolved as I reflected on the bigger picture about my study. What was similar for all three teachers is that when teachers began to teach using embedded assessment it

enhanced their repertoire about teaching for understanding. It also moved the teachers towards constructivist ways of teaching and learning. For example, Marian and Lisa began to talk about analyzing kids' reasoning. To do that, they had to allow them to talk and write. They had to give them a platform to express their ideas and state their ideas clearly. They had to give them opportunities to interact and share ideas with peers. They had class presentations that allowed her students to present their work and be criticized by peers. All these points are closely connected with constructivism and teaching for understanding.

Marian's students came from low and lower middle social class families. Marian reported that her students had outside school factors that impeded their success at school. She wanted to teach all her students and not just a few. Marian's classroom changed after embedded assessment. There was less resistance from students. Why? Because Marian was having a tool to use for them to be active learners and allowing them to talk among themselves and share ideas. Marian' s classroom appeared to be more of a constructivist driven type of learning.

On the other hand, Lisa believed that she could not help all her students because there were so many bad things that happen in their lives that affects their performance in school. Because they came from poor families, who maybe had parents working two jobs, they had no time to be supportive to their kids. Some of them, Lisa believed, their home environments were not conducive to success at school. This belief about students' socioeconomic status of parents being the best predictor of that student' performance was interesting to me. Because it seems to me that Lisa had given up on some of her students

due to the fact that they came from poor or dysfunctional families and they had many problems. Given this information, why should teachers like Lisa not believe that the net effect of teachers is more dependent on students' native talent and opportunity than anything else? This to me means that these students are disadvantaged from an early age compared to their counterparts who come from well to do homes. After Lisa had tried some embedded assessment, Lisa shifted her focus from seeing students with problems and to concentrating on helping them with school.

Based on my years of experience in working with teachers I have noticed a tendency on focusing on things that are beyond their control like family background. I have developed a stance that teachers should focus on what they can do rather than what they cannot control. This requires a shift in mindset. Lisa's shift was due to participating in this project. Lisa was now focusing on helping students learn. She was involving students more in class discussions. She was helping them with how to state their ideas clearly and writing their thoughts. It seems to me that when teachers use embedded assessment systematically it forces them to involve students more and to let them talk and share ideas. I do not think that teachers can use traditional didactic approaches for embedded assessment because it requires teachers to find out their students reasoning. I will revisit this later in this chapter. It also seems to me that there was a shift of roles in Lisa's class. The role of students before embedded assessment was: *"to be little soldiers, they have to pay attention and do what I said"LL/interv1p12/March 2000).* This model is based on old theories of learning and traditional views of testing. These theories are based on that learning occurs by accumulating atomized bits of knowledge and tests are

recalling what you have learned. Through the use of embedded assessment Lisa was moving towards the contemporary views of learning. (Constructivism)

Sarah, on the other hand reported that she was concerned about her students and wanted to involve all in her lessons. Sarah believed that embedded assessment had an impact on her students because when they drew an ecosystem on a poster, they were proud of their work and enjoyed learning.

To conclude, this section about the impact on students, I have asserted that Marian believed she could help all her students and embedded assessment gave her a tool that helped to reach far much more students than before. Lisa believed, she could not teach and reach all her students and after embedded assessment, Lisa changed that belief and concentrated on helping them learn and improve. The change in Lisa's perspectives set a different tone in Lisa's classroom. The students became engaged more in the classroom. One factor that appeared to contribute to this was the teacher's attention to students' ideas and her focus in trying to help them become better writers of their ideas. On the other hand, Sarah did not help students with their poor writing skills because I suspect that she believed that their level was too low for her to bring it up to expectations. She used oral assessments only. Her students had productive classroom interactions and discourse that involved students connecting scientific ideas to their life situations and experiences.

Impact of embedded assessment on Teaching

All the three teachers reported that embedded assessment was connected to

teaching for understanding. Marian started this project with a desire to teach for understanding and to help her students to connect what they learn and see coherence among lessons and situations in their life. Marian reported that embedded assessment was a tool she used to accomplish her goal of teaching for understanding.

Embedded assessment increased Lisa's repertoire of teaching strategies. She reported that she was trying a few that she had not done before. Although Lisa took a long time to embrace embedded assessment, she believed that embedded assessment helped her to focus on the process of learning and teaching. It helped her to look more carefully and closely at students, their learning and their work. Lisa was also reading students' work carefully to find what they were thinking with two purposes in mind: to design appropriate instructional moves and to give feedback so students could use it to improve their work. Lisa's feedback was mainly in the use of questions and asking students to reflect more on what they were writing. Lisa's willingness to try out new teaching/assessment strategies set a new atmosphere in her classroom. Lisa reported that she was re-teaching key ideas several times whereas before she will cover it once and move on to the next key idea. This way she was able to help students with difficulties and therefore increasing the number of students who understand the concepts. Lisa helped her students with writing and gave challenging work.

On the other hand, Sarah believed that embedded assessment had enhanced her thinking about teaching. She reported that embedded assessment helped her to focus on understanding of concepts. It made her re-teach concepts that she thought were not completely understood. Embedded assessment seems to have had a slight impact on

Sarah's teaching. Why? Because even though Sarah used embedded assessment to find what she needed to do better, she continued in her old ways of thinking about her students. As I have already discussed, she thought her students could not write and therefore she did not help them with their writing skills. Though some of her oral discussions were quite lively and engaging for students, I think that the impact or influence on her teaching and the project would have been much stronger if she had tried to help her students with writing. At the same time, I think that Sarah and her students benefited from participating in this project because the interactions in the classroom changed.

Sarah and her students were interacting about scientific ideas. Students were bringing in their life stories. This might mean that they were connecting science to their everyday lives. Students interacted about their ideas and science. The discourse in Sarah's classroom was not her telling them the correct way or correct words. Instead it was Sarah who was guiding her students in reconstructing their understanding based on the scientific ideas they were learning. Embedded assessment helped Sarah to reflect about education in general and her methods of teaching. Even though Sarah did not change much in her practice, she had started thinking deeply about what it means to teach effectively and in general. Sarah was reflecting on why students were not willing to engage in school. Her answer was that school was not entertaining. Sarah was beginning to think about the issues of making schools exciting for young people. If it were not for involvement in this project, Sarah would not have thought about these issues. Sarah proposed that because the society is heavily influenced by technology, it is time to

involve more technology in the classroom. She also, questioned the feasibility of her suggestions. But I think what Sarah was saying is consistent with my argument that we need to help teachers change their values, beliefs and skills. I will discuss my argument in the conclusion chapter.

To summarize, all the teachers acknowledged and described how embedded assessment helped them to teach for understanding. Marian saw this as enabling her to achieve her goals. Lisa reported that embedded assessment helped her to increase her repertoire of assessing and teaching. It helped her to teach writing and to teach kids to express their thoughts on paper. Sarah reported that embedded assessment helped her to reflect about her teaching and schooling in general. Embedded assessment had a minimal influence on Sarah's teaching but her oral assessments were engaging for students.

Impact of embedded assessment on views and practice of assessment

All the three teachers changed their views about assessment. Marian used assessment as a way to give grades. Lisa used worksheets and fill in the blank types of assessments to give grades as well. She thought that worksheets were teacher friendly, efficient and faster way to grade students. Marian used a combination of multiple-choice and some elaborated answers type of questions. Sarah reported that she had never heard about the word 'embedded assessment'. To her assessment meant testing. But this project influenced the three teachers to view assessment as an integral and essential part of teaching. Marian tried her level best to use that concept i.e. teaching & assessing and then adjusting lessons. But Lisa, because she thought that this idea of using assessment was good because it helped her and her students to understand science or teach for

understanding. She thought that it presented pragmatic problems for her and therefore, she decided to use embedded assessment for difficult concepts only. She was going to base this on her seven years of wisdom from practice. Sarah used a lot of good oral questions in her classroom. She believed that given the profile of students she had, she was going to concentrate on oral assessment only. It seems to me that Lisa saw the idea of giving quality feedback as an important component of embedded assessment. And that, it was feasible to give students constructive feedback than for her to re-teach concepts. Lisa and Sarah seem to have redefined embedded assessment due to their beliefs about what works in their classroom. The impact on these two is that they have reconstructed the meaning of embedded assessment to suit what they believed was plausible.

Impact of embedded assessment on teachers' perspective about planning and reflection

Marian's planning had shifted focus from textbooks and other resources to students. Because of this Marian is not asking what should I do tomorrow? Instead she was asking: What happened yesterday that enables me to plan what to do next? It seems to me, embedded assessment helped Marian to have a concrete framework to plan instructional moves. Because Marian is a beginning teacher she was facing management problems and most of her reflection before embedded assessment was centered on classroom management issues. But after embedded assessment Marian reported that her behavior problems were still there, but had gotten better. Her reflection was now concerned with teaching and learning.

On the other hand, embedded assessment helped Lisa to plan and reflect

differently. Her planning was not only based on the district guidelines but also on what was happening in her classroom. Embedded assessment became Lisa's tool for planning. Her reflection was based on occurrences and students' work. Her planning and reflection was now focusing on how she could improve learning and teaching in her classroom.

Although Sarah planned with her team on a daily basis, the planning was not based on the substance on what and how to teach and reflecting on what happened yesterday. Sarah reported that it was mainly focused on the question: what should we do today? And strategies for managing problems with behavior in the classroom. Embedded assessment influenced Sarah to plan carefully her daily lessons and to think about the questions she will ask. It made her flexible in her planning than before here she followed exactly what she was supposed to do, regardless of how her students responded. It seems to me that embedded assessment was giving teachers a concrete way of thinking about planning. I will now turn to address my last question which is: what were the challenges, problems, tensions and struggles that the three teachers faced as they learned about and utilized embedded assessment in the classroom?

Tensions, problems, struggles and challenges that teachers faced as they learned about and used embedded assessment in the classroom.

In this section, I discuss the kinds of problems, tensions and challenges the teachers faced as they tried embedded assessment in their classrooms. The diagram below summarizes the key findings about problems and tensions. I have organized this section under the following constructs that emerged from my data: I) Tensions that relate to the teacher's biography and her conceptualization of embedded assessment, 2) Problems that

relate to the students, 3) Tensions that relate to the school as a system, 4) Tensions that relate to parents and *5)* problems that relate to the society at large. I will discuss each of these by comparing and contrasting data for the three teachers. I will end up with a summary for this section. I will start by explaining the model presented in the diagram below. It represents what I saw happening with the three teachers. I saw the teachers at the center of nested contexts. The teachers were trying hard to use and learn about embedded assessment but there were all these problems that surrounded the teacher. Once again these problems are not new as we have already seen in chapter 2 (review of related literature). If one new thing is introduced in education, all these other problems will appear.

I call these enduring tensions in education. (borrowing from Ann Liebermann's work)

1) Tensions that relate to the teacher's conceptions of embedded assessment

I have already discussed this in the section about how the teachers made sense of embedded assessment. But as a summary, I want to bring the attention of the reader to the following problems. Lisa and Sarah redefined embedded assessment because of their beliefs about what works in the contexts. The problem here is that each teacher comes up with their own conceptualization of embedded assessment that fits them. And this makes it difficult to compare and contrast because it becomes what each teacher makes it to be. This is similar to having many faces. By this I mean, that when these teachers talked about embedded assessment they meant different things. This is problematic and it has

implications for the education community at large, which I will discuss later. Marian was different from the two teachers because her conception was similar to that of the project. This maybe because she might be novice about schooling since she is only beginning. One might argue that she has not experienced the realties of school life. On the other hand, it seems to me that the ideas of the project fitted well with her beliefs and the type of preparation she received at her college.

Embedded assessment is influenced by how the teacher understands it, whether they buy into the idea and if they are excited about it. Lisa was not excited about embedded assessment because in the beginning she saw it as presenting pragmatic challenges. Her established beliefs, values and practices interfered with her ability to do embedded assessment as the project leaders envisioned. The previous experiences (autobiography) often do not help teachers as they struggle to enact the new ideas. At times past experiences can act as obstacles. For example Lisa, who is a product of a system that places emphasis on grading, must reorient her thinking to embedded assessment and engage students in complex reasoning. Lisa is a product of the very system she was trying to change. This can be challenging for teachers.

On the other hand, Sarah who is a social studies teacher was asked to teach science. She participated in this study because my original teacher dropped because of cancer-related sickness. So, I asked her because I could not get anybody to replace the other science teacher (I talk about this in my methods chapter). This context is in itself problematic for embedded assessment because of lack of science content knowledge. Sarah was also part of a team that although they said they were supportive of her

involvement in the project, they kept her from focusing on embedded assessment. Sarah had a third of her students as special education students and she had established beliefs about their potential. She believed that they could not write and therefore did not provide opportunities for them to write. What about the 2/3 of her students who are not special education are they not being short changed by the circumstances in the class? When I asked this to Sarah, she replied that her major goal was to help them survive school. Sarah had some management problems in my observation notes I wrote the following reflections after two weeks in her classroom:

> *The teacher faces behavior problems even though there is always one teacher who is available to help. The teacher spends more time dealing with disruptive behavior. I checked my watch today it was almost a frequency of every other 2 minutes. Sarah talked to me after class about her lack of confidence about science content knowledge. She said that some of her students were aware of this and doubted the credibility of the information given. (FN/p16 March 2000)*

This context makes the case of Sarah an interesting comparison case and a difficult case at the same time. It is difficult for a teacher without content knowledge to do embedded assessment. Sarah was aware that this was a limiting factor for her. Deep science content would have enabled Sarah to look into explanations, interpretations, discussions and deeper analysis involved in the teaching of the subject. Sarah had difficulties with analyzing the content or ideas that her students were giving her. This made it difficult for Sarah to do embedded assessment.

Another problematic area was her beliefs about her students. Sarah had deep

ingrained beliefs that her students could not write and she was not going to help them with writing. Instead most of her assessments were oral. Sarah did not change her stance about students throughout the study.

Challenges that relate to students

When I started this project, I strongly believed that students would accept embedded assessment. But this assumption proved wrong in the three teachers' classrooms because some of the students especially the honors' students resisted being taught science this way. All the teachers reported that in teaching using embedded assessment students have to 'buy' into being taught this way. Marian believed that if students strongly resisted the teacher might revert to their old way of doing things basing it on the claim that 'it does not work for my kids'. Why did some of the students resist? Firstly, because students have been apprenticed on 'how to do school' in the past seven years of their schooling life. Some have been successful even without understanding anything at all. It was hard for the teachers to break the cycle of seating, listening and being inactive. This way it does not require hard work from students and thinking is minimal. Secondly, Marian reported that the timing of this project was problematic because I started in the spring instead of the fall. The students were already used to her style of teaching and the culture of the classroom was already established. Marian reported what I call the 'right answer syndrome' problem. This is when students do not want to understand the phenomena but just want to be told the right answer. All the teachers felt that there was a need to 'train' or model various aspects about embedded assessment.

All the teachers discovered that some of their students lacked basic skills. They

reported that the embedded assessment principles advocate that teachers should help them with those basic skills. But if they did this they were not going to be able to teach them science. The dilemma the teachers faced was whether to cover the curriculum or to help students with basics skills. Marian decided to teach science and help with basic skills at the same time. Lisa decided to help her students with writing skills, which was going to help them express their ideas on paper. Although Sarah was aware of her students' problems or difficulties,she decided not to focus on that at all. What I am learning from the three teachers is that we should not consider students as beneficiaries of this approach only but as active participants with a powerful influence on the project's success. Therefore, the project should have a two-pronged focus of teachers and their students. Sarah had some classroom management problems, which fluctuated daily. Even though there were two adults present in the class, still she faced behavior problems. Lisa did not have many problems with behavior. She was always almost in control until she used embedded assessment systematically. She began to give some control to her students. Marian a beginning teacher started this project with major classroom management problems. Her classroom looked like a zoo but with an increased use of embedded assessment those problems began to decrease, although they did not completely diminish. But it got better with more use of embedded assessment. Why did it get better? In her words, Marian said

> *That you are listening to them helps with value. It helps with their self-esteem as well as their schoolwork some students really want to share more. I think a lot of these students don't get anything at home, or they do not get a share time, or their parents may not listen to them very much at all. So, I think it helps them to know that somebody is listening to them because of value. Valuing what they say helps with behavior, because they want to participate now instead of just sitting*

there. ('MJ/ iniерv5/pl 7/May 2000)

Marian was noticing a decline in disruptive student behavior because Marian an important person was listening to them. Another problem that Lisa talked about was the attitude of students towards school. Lisa saw this as her greatest challenge. She reported that some of her students came to school to socialize instead of learning. She said, they did not care about science and school in general. I agree with Lisa, on this aspect because having had sat in teacher's classrooms the past three years for various projects, I can attest that this is a much bigger problem that needs a lot of attention.

3) Tensions that relate to school as a system

a) Strong subject matter knowledge

Marian and Lisa reported that they noticed that in areas where they were weak in subject matter content knowledge, it was difficult to use embedded assessment. Marian used the analogy of the 'blind leading the blind'; they will never get to the desired destination. She said, it was particularly important for her to have strong subject matter so that she can be able to pick up misconceptions and look at the bigger picture about students' understanding of science. She said it would be difficult to lead her students to desired scientific reasoning if she herself lacks that scientific knowledge. Strong subject matter includes knowledge of the content (key ideas, concepts, organizing principles) as well as the substantive and syntactic structure of the discipline (Schwab, 1978, Shulman 1987), which may lead a teacher to analyze the explanations, interpretations, discussions and written tasks in the process of using embedded assessment. Sarah's science content

was weak and she was aware of that. This explains the slight impact of embedded assessment because Sarah had challenges in analyzing what her kids told her about scientific ideas. How do you analyze something that you are not comfortable you understand yourself? Her students were even aware of her lack of science content knowledge and this might explain why they behaved badly in her classroom. Sarah reported that some of her students did not trust the information they learned in her class. Embedded assessment further revealed to her the importance of science content knowledge.

Time versus amount of content coverage

Marian reported that when teaching using embedded assessment it was taking her far too long to complete the district objectives. She believed that embedded assessment slowed down the pace of content coverage. Why was this a problem for Marian? Marian was a new member of the science teachers in the school so it seemed to me that she was well aware that acceptance by her colleagues was important. One of the ways that she could do this was to cover the curriculum and assure the eighth grade teachers that her students had completed all the topics they were supposed to cover in seventh grade. But Marian did not choose that path. 1 perceive this was also influenced by what her goals were and her beliefs about teaching and learning which were to teach for understanding. But she reported that she would be pleased if she managed to cover all her objectives. The other factor might be that her students were going to take the MEAP (Michigan Educational Assessment Program) so it will be important to prepare her students for the MEAP by focusing on coverage. Marian complained about embedded assessment

because she was not sure when was it time to move on, how many times to re-teach so that they completely understand. Marian was facing the tension of whether to cover content or to teach for understanding. The problem that Marian faced was a school system issue. We can see that even in the system Marian made choices or decisions that fit her belief system. Therefore, Marian faced the problem of coverage versus understanding because embedded assessment enabled her to focus on understanding.

Lisa reported that one of the problems she had with the embedded assessment project was class size. She wondered how was it going to be possible to help students who came to her with different levels of understanding. How she could handle 125 misconceptions at the same time. If she tried to do this, Lisa believed that she would cover fewer topics. This brings to surface the problem of time that Lisa complained about. She felt that to use embedded assessment she needed more time to re-teach and make sure her students were grasping the concepts. But she was expected to teach all the objectives in her district curriculum and felt that by using embedded assessment she will not be able to finish. Lisa reported that, if that happens she will feel guilty that she did not do her job. This to me brings issues of how teachers see their role is. Is it to cover curriculum or is it to teach students so they can learn and understand science? When we started this project Lisa wanted to be both a director and facilitator of her students learning. But now through using embedded assessment she finds that being a facilitator of learning takes time and therefore she might not be able to help students with one of her goals i.e. to get them ready for 8th grade. There is a misconception sometimes in teaching that content coverage equals learning. I argue that content coverage may not necessarily

mean learning or understanding scientific concepts. This view is supported in the pedagogies literature. But the overall problem that Lisa was facing is that schools the ways they are structured and designed inhibit her ability to do embedded assessment effectively. What I have learned from the three teachers is that using embedded assessment is directly intertwined with new goals of science education, and 'new' theories of learning; like constructivism.

All the three teachers agreed that embedded assessment was a good and maybe a better idea that needs to be given attention. But the problem is that they are being implemented in an old system that was designed with old goals like producing scientists and seeing learning as acquisition of facts. These ideas were appropriate and fitted well in the old system. It appears that a system of schooling that fits these ideas is needed because we cannot put new wine in old wineskins. Sarah's views were also consistent with Lisa's and Marian's. The major problem Sarah complained about was time and frustration that schools are not serving students well. She believed that there is a need to search for better ways that emulate what amuses young people in the society. She gave an example of using technology and getting computer games that entertain kids.

Problems that relate to parents

Another concern for all the three teachers was the issue of accountability to parents and the administration. All the teachers reported that most parents place a heavy emphasis on grades. Teachers said that most parents are interested in the grade that their child is getting in science. They reported that administrators too want teachers to focus on getting good grades on the state test. They said that their building administrators were not

supportive of using embedded assessment. Teachers believed that they needed support from parents, administrators and other teachers in the building to be successful in using embedded assessment. Teachers stated that most parents were not involved in their kids' schooling and it is hard to get them to attend school functions. Lisa described that most of her students came from backgrounds where parents themselves had problems in their lives. She believed that this affected the child's performance at school.

Problems that relate to the society at large

Lisa and Sarah believed that students bring in societal problems at school. These societal problems may hinder the teacher's ability to use embedded assessment. For example, Sarah noted that the American society loves being entertained. The society wants quick and fast things. Her students wanted her to be an entertainer. Sarah believed that embedded assessment is hard work for both the teacher and the students. Marian and Lisa reported that some of their students resisted learning using embedded assessment. These two teachers used both oral and written tasks. But Sarah used oral assessments only. This may explain why her students did not resist as the other two teachers. The teachers argued that if embedded assessment is designed to diagnose student's difficulties some of these are due to societal problems and the home environment. Then, the teacher has to help with all those problems.

Summary of the cross case analysis

I have discussed that all the three teachers passed through stages in learning and

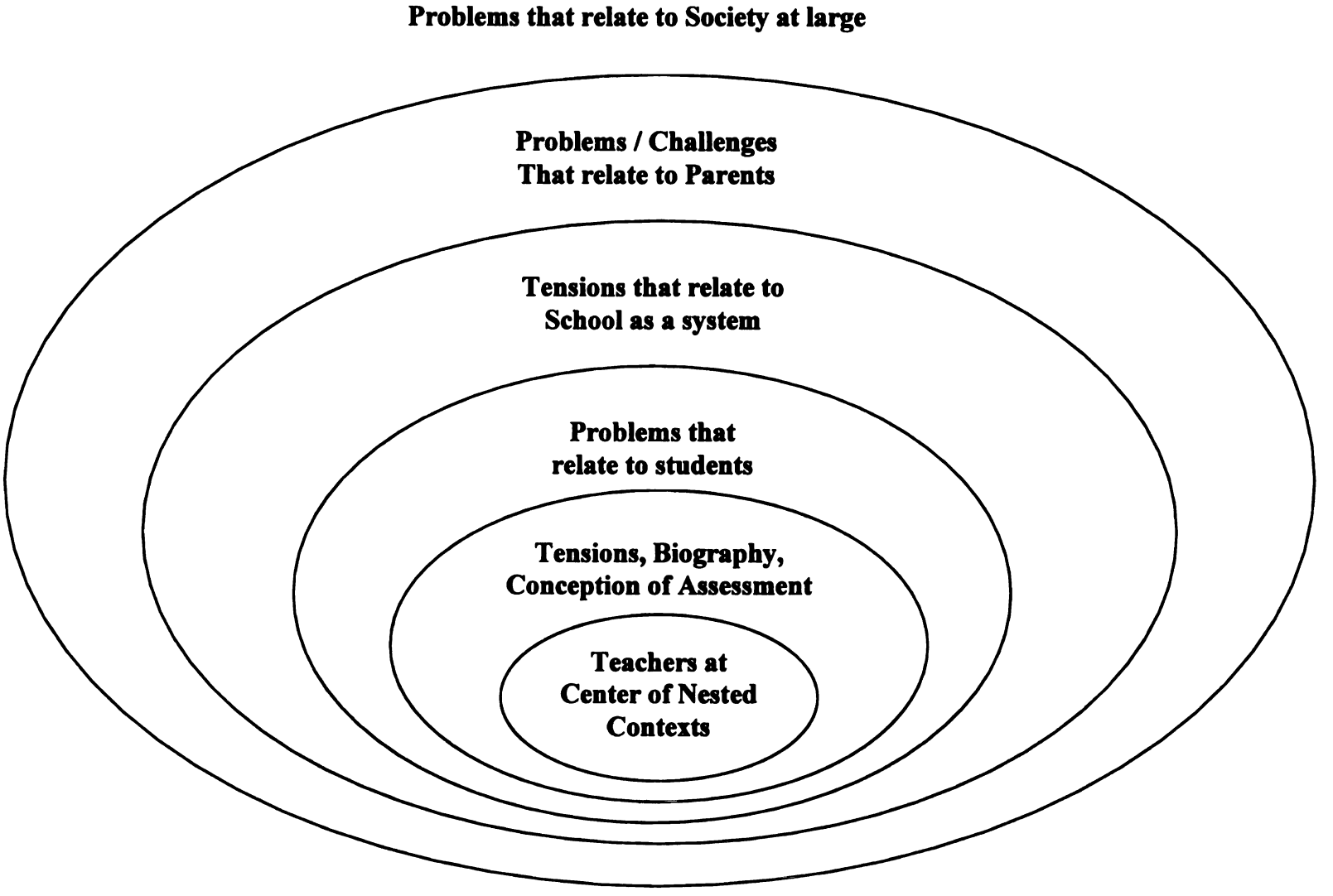
using embedded assessment. These stages indicate the way the teachers were making sense of embedded assessment. But the stages are different from teacher to teacher. The way each teacher made sense of embedded assessment was influenced by their beliefs about students, teaching, learning, assessment ad what was practical given the context of use. I have shown that Marian understanding of embedded assessment was more complex than the other two teachers. All the teachers reported that embedded assessment was difficult for them and their students. It required teacher and students to have 'new' skills. Even though embedded assessment was difficult and challenging all the teachers did not give up because of the support system from the professional development and the classroom visitations.

What teachers decided to focus on in this project was different. Marian focused on all the aspect of embedded assessment. Lisa started by giving constructive feedback because this fitted well in her schedule. It did not disrupt her daily operations. Later, Lisa had a turning point in this project that made her to focus on her kids' writing and writing in a science classroom. A different kind of writing than what she used before. She was asking them to write to learn and communicate ideas rather writing one word answers in a worksheet that do not indicate to her how the kid was making sense of scientific concepts. Sarah decided to focus on oral assessment and did not change her stance throughout the project. Because of these different foci points embedded assessment took many different shapes in the three teachers' classrooms. Marian used embedded assessment systematically and made a decision that she will not focus on coverage of content. Towards the end of the study, Lisa came up with an idea of making embedded

assessment 'doable.' She decided that she would use embedded assessment for difficult concepts only based on her wisdom of practice. Because if she used it as Marian did she was going to feel guilty for not covering the district objectives.

All the three teachers reported that embedded assessment was a good idea. Teachers reported that embedded assessment had influenced them, their students and the classroom environment in a positive manner. Teachers were clear and vocal about the kinds of tensions and problems they faced in this project. In the next chapter, I will discuss findings in relation to other studies.

Figure 7.1 Summary of nested contexts of tensions and problems that teachers faced



CHAPTER 8

DISCUSSION OF MAJOR FINDINGS

In this chapter I discuss major findings of this study in relation to other research. Analysis of the data from this study has revealed seven categories of research that are related to the study. What is unique about this study is that it is studying teachers at the intersection of all these dimensions of the research literature. The literature dimensions are: 1) assessment, 2) educational change and innovation, reforms in education-science education, 3) teacher learning and teacher change, 4) professional development, 6) constructivism, and 7) teaching for understanding. In chapter nine, 1 will present the framework that evolved from data analysis and these fields of study.

I do not present the literature and working definitions as absolutes. I anticipate that some readers will disagree with what I have included, left out, or construed as meanings of these literatures. Readers will have their own definitions of these concepts, however similar or dissimilar they are. I know that each of these literature dimensions have a body of literature many volumes thick. The literature in one dimension often overlaps and interrelates with others. Several share similar and parallel arguments. In studying Marian, Lisa and Sarah I have come to see the combination and interconnectedness of these theoretical roots as illustrative of learning and teaching using embedded assessment. I have organized the discussion of findings under the following

categories: 1) making sense of embedded assessment, 2) displaying how embedded assessment looked in the classroom, 3) impact of embedded assessment and 4) problems, tensions and challenges associated with learning and using embedded assessment.

1) Making sense of embedded assessment

In the previous chapter, I asserted that the three teachers passed through stages or phases in making sense of embedded assessment. However, these stages were different from teacher to teacher. In this section, I discuss how this assertion relates to earlier work. I have organized the discussion under the following categories that emerged from data analysis: a) stages, beliefs and contexts, b) compromised meanings of embedded assessment, c) embedded assessment was perceived as difficult and challenging and d) the support that helped teachers to continue in the project.

a) Stages, beliefs and contexts

Teachers passed through stages in learning and using embedded assessment. The stages were different from teacher to teacher. These stages were marked by adjustments in thinking, beliefs and or practice. The way each teacher made sense of embedded assessment was a result of their beliefs about students, teaching, learning, assessment and their analysis of what was practical given their classrooms and the school system. The teacher's conceptualization of embedded assessment seemed to be influenced by what happened in the teacher's mind and what happened when used with students. For example, Sarah's mental block in conceptualizing 'embedded assessment' was using the word 'assessment', which to her meant testing. Therefore, the making sense of embedded

assessment was in stages and it was influenced by teachers' beliefs and the context of use.

These findings relate to Loucks-Horsley et al (1998) who pointed out that change does not happen in one step, but is progressive. They stated that individuals go through stages in how they feel about change and how knowledgeable and sophisticated they are in using it. I want to point out that in my study, progress was questionable for one teacher. Progressive gives the impression that there is improvement. But in my study, Sarah did not show that progressive nature in some aspects. For example, she stuck to her beliefs about her students from start of the project to the end. She improved in some aspects but not all.

Fullan (1991) also argued that change is a process and not an event. It happens in stages. The stages for the three teachers in the study were associated with either two or more of the following: doubting, questioning, rejecting and complaining. Fullan (1991) found that in learning new ideas, teachers might experience anxiety and struggle. This process involves passing though zones of uncertainty and being lost. Marian reported that she was not aware of what she was doing that could be called embedded assessment. Bell & Cowie (1997) in their three year study of formative assessment found out that teachers were not always aware of exactly what they were doing that could be called 'formative assessment'.

Bruce & Peyton (1999) argued that teachers are never passive recipients of new ideas or approaches, rather they are active agents in determining what the innovation means. They stated that the way a teacher makes sense of and shapes a new idea is a complex process influenced by that teacher's theories of teaching and learning, the

teacher's individual personality, and preferences he or she has in place (Cohen, 1988; Cuban, 1986; Elbaz, 1982; Fullan 1991). This is related to the three teachers in my study. But my study further supports Lieberman's (1999) work, in which she argued that the strong connection between students' learning and teachers' workplace conditions must not be ignored. For one teacher in my study, her conceptualization of embedded assessment was influenced by what happened in the context of use. To use assessment this way (embedded with teaching) there is a need to pay particular attention to teachers' workplace, i.e., the context of use. For example, Sarah was working with a team of teachers who were not familiar with embedded assessment and in some ways could not support her in this project.

b) Compromised meanings of embedded assessment

Lisa and Sarah redefined the meaning of embedded assessment. They approached embedded assessment in a variety of ways. They decided to focus on different aspects of embedded assessment. There was an uncharted territory open to exploration and invention. Lisa and Sarah understood what the envisioned meaning of embedded assessment was, but they constructed a meaning of embedded assessment based on what they believed worked for them and their students. Marian used embedded assessment as envisioned by the project. At the end of the project, Lisa decided to use embedded assessment for difficult concepts only. I argue that this is actually redefining what embedded assessment means because it is no longer continuous and ongoing, and it is no longer based on information gathered from students in that class. In this way, Lisa was planning to use embedded assessment sporadically. But I found out that even if it was used sporadically there were some effects on students and teachers.

Loucks-Horsley et al (1998) argued that most systems resist change because the change does not fit within the school system. One might argue that the veteran teachers in my study had known the system well, unlike Marian, so they were knowledgeable about what works within the system. Lisa thought that the logistics of doing embedded assessment were next to impossible. Lisa saw the system in which she was working as an impediment to trying embedded assessment. These findings are consistent with what Tyack & Cuban (1995) described as 'the grammar of schooling'. They argued that as long as the grammar of schooling persisted, fundamental change would not be attainable. The grammar of schooling is the way schools divide time and space, classify students and allocate them to classrooms, splinter knowledge into subjects, and award grades as evidence of learning. Lisa's struggle with a conceptualization of embedded assessment was associated with specific issues like the idea of not placing emphasis on grades. These were important to Lisa and the system.

Lieberman & Miller (1999) pointed out that teachers needed to think in new ways in order to embrace new ideas. They argued that teachers have to be willing to think 'out of the box'. This relates to Lisa in that she had to think 'out of the system' for her to accept embedded assessment. But this makes me wonder if that is possible, because she was already in the system. Bruce & Peyton (1999) argued that for any new instructional practices, little thought is given to the influence of the social setting (the classroom, the school, the district in which the innovation is to operate) despite compelling evidence that new practices are rarely adopted to the degree or in the manner that the originators of these practices envisioned. The innovations challenge established beliefs, values and practices. In response to these challenges, teachers create new practices that reflect

complex and situation specific compromises between the old way of doing things and the new. This is consistent with what happened to Sarah and Lisa.

Patterson (1993) has also argued that the behavior of individuals in a system is dictated by underlying structures, this might explain why Lisa and Sarah redefined embedded assessment. It is the systematic challenges that caused Lisa to alter the original conception of embedded assessment. Building on earlier work, (Fullan, 1991; Sarason, 1996; Liebermann & Miller 1999) this study enlarges our understanding of classroom change. It is not only about changing teacher beliefs and attitudes or about paying attention to the structural influences, but it also depends on the teachers' analysis of what works in her particular classroom. This may mean that there is no one best way of doing embedded assessment. This makes the conceptualization of any new approach complicated, because each teacher will work differently from the next even though there were patterns across the three teachers.

Each teacher will come up with his or her own meaning and it might be challenging to have common language that means or refers to the same meanings of the concept. The findings of this study suggested that embedded assessment is what each teacher makes of it. Ball (1995) has argued that teaching is context specific and that even skilled teachers must adapt their practice in particular situations.

c) Embedded assessment was difficult and challenging for the teachers and their students

All the three teachers reported that embedded assessment was difficult and challenging for them and their students. It was challenging for teachers because they needed to learn new skills and teaching strategies, and had to revise what they had

believed about assessment, i.e., they had to confront established beliefs about assessment. Teachers reported that they had not seen other teachers model embedded assessment. It was difficult for students because students have been learning how to 'do school' for the past seven years. Attempting to change that causes resistance. Also, teachers reported that starting this project in the middle of the school year was problematic because there was a classroom culture that was already established. This suggests that timing is important for professional development.

Fullan (1991) pointed out that change is difficult and riddled with dilemmas, ambivalences and paradoxes. He stated that change combines steps that do not go together: to have a vision yet be open minded; to take initiative and to empower others; to provide support and pressure; to start small and think big; to expect results and be patient; to have a plan and be flexible; and to experience uncertainty and satisfaction. In my study learning about and conceptualizing embedded assessment were difficult because of the tensions and problems and challenges that the teachers faced.

d) The support system helped teachers conceptualize and continue in the embedded assessment project

Even though embedded assessment was difficult and challenging for the teachers, they did not give up, because of the support system provided by the professional development sessions and my classroom observations. This can be seen in the differences between Marian and the other two teachers. I had an opportunity to have casual conversations with Marian soon after the class she taught but the other teachers it often was the next day or two before I was able to talk and reflect about what occurred in their classrooms. Marian seemed to have had a complex conceptualization of embedded

assessment that was close to our original vision. In the professional development meetings, teachers discussed their conceptualization of embedded assessment. They also talked about teaching/assessment strategies they used in their classroom, challenges they were facing, and possible alternatives that could address the problems. For example, teachers decided to design a lesson plan and focused specifically on what they would do in terms of embedded assessment. This especially helped Marian, who was struggling with not being sure what embedded assessment was.

These findings are consistent with earlier research on professional development. Darling Hammond & McLaughlin (1995), Little (1998), Abdul Haqq (1995) have identified features that characterize effective professional development. These include: it should be ongoing, embedded in teacher work, collaborative, and provide opportunities for teachers to interact with peers, and provide adequate time and follow up support. One of the features that helped teachers to continue in my study was this follow up in the classroom. Because of this, the kinds of conversations that we had were deeply based on classroom data observation. Sometimes, in the professional development meetings, I would ask one teacher to share some things that worked and others that did not work. I perceive this was helpful for teacher growth and conceptualization of embedded assessment. What I learned from these professional development sessions is that follow up is not just needed, but it is essential and shapes the professional development in ways that would have been impossible without it. I have said earlier on that Lisa was very good in talking and articulating educational language, but when I visited her classroom, I found a different story. Therefore, if we are really serious about helping teachers change their practice and help in the conceptualization of new ideas, we need not only ongoing

workshops but also ongoing visits to the teacher's classroom. This also enabled me to see some aspects about embedded assessment that I had not thought about. For example, students need not only be thought as beneficiaries, but also as participants in the learning and using of a new idea. Lisa might not have had a breakthrough in this project, because she knew how to talk convincingly about contemporary education ideas, but the problem she had was the enactment of those ideas in the classroom. If I had not visited her classroom, I would have thought that she was sailing through the project. But through being in the classroom and working collaboratively with her, I was able to suggest small changes that provided evidence about her students' understandings. This evidence helped her to reach a transitional stage in the embedded assessment project.

To summarize, the three teachers made sense of embedded assessment in a complex set of stages. The making sense of embedded assessment was influenced by the teachers' belief system and the teachers' analysis of what worked in their classrooms. Two of the three teachers redefined the meaning of embedded assessment and how they redefined it appears to add to the literature. Many researchers have reported that teachers will adjust the meaning of new educational ideas, but few have addressed what the redefined meaning of embedded assessment is. All the teachers reported that embedded assessment was difficult and challenging. This is not new. The teachers in my study valued the support provided by the ongoing professional developments and the frequent visits in the classroom. What is particularly interesting is that Lisa would not have changed her use and conceptualization of embedded assessment if she had not gotten the support.

2) Displaying how embedded assessment looked like in the classroom

In chapters four, five and six I included vignettes of the three teachers' classroom with a focus on the process of learning to use embedded assessment. Any picture of embedded assessment in practice is incomplete for at least two reasons. First, working with the framework of embedded assessment (introduced in chapter one) is like participating in a reflective dialogue about principles of practice. It is a process of planning, enacting and reflection in relation to the abstract concepts in the framework and reinterpreting one's understanding of it in light of this experience (Wiske 1998). Any attempt to capture a picture of embedded assessment in practice illustrates only a part of the ongoing process. Teachers are always trying to accomplish multiple purposes simultaneously (Ball, 1996). Because of these challenges, the vignettes about the three teachers' classrooms provide inevitably limited representations of findings about embedded assessment in practice. Yet these vignettes were an attempt to honor the unique, multifaceted, situated reality of teachers' practices while highlighting the elements of embedded assessment.

Wiske (1998) argued that teaching is a dynamic act of interpretation shaped by the unique requirements of the subject area, designated curriculum, school culture and particular students. So, what was common about sequencing instruction when using embedded assessment? What moves did the teachers make? The teachers started by giving students a task that helped to **investigate** students' ideas though an initial open-ended exploration, discussion or brainstorming session. The teacher would then **analyze** that information so she could **design** instructional strategies. Teachers then structured

tasks that were based on the kind of information they obtained from students. Students learned from one another's examples and comments when they worked together. This cycle then repeats itself with the next day's activity based on yesterday's lesson. This was not easy for teachers because, as Ball (1995) noted, no matter what kind of research we do in the future exploring students' knowledge and preconceptions, examining what they know is difficult and teachers will continue to confront such uncertainty on daily basis. Can a teacher become skillful at probing and making sense of students' ideas? Yes. But what teachers know about their students can never be certain or complete. The teachers in my study reported some of these concerns as well. The practice of teaching is uncertain as well (Lortie, 1975).

Embedded assessment took many forms and shapes in Marian's classroom. In Lisa's classroom, embedded assessment started as piece meals of feedback and helping with writing skills. In Sarah's classroom embedded assessment was oral throughout the project. However, there were some similarities in how embedded assessment looked in the three classrooms. The problem with this was that it was difficult to see, because some parts of it were happening in the teacher's mind. I was able to figure this out during interviews with the teachers. Sometimes, teachers themselves were not aware that they were doing embedded assessment. But once they became accustomed to it, it was easier to talk about what was happening in their classrooms. Although there were subtle differences in the way embedded assessment looked in the three classrooms, the change in all three classrooms was noticeable.

Wiggins (1998) described classrooms where assessment was formative. He noted that the conversations in the classrooms were different from those heard in schools that used traditional assessment. He found out that students no longer ask teachers, 'is this

what you want?" Or, 'is this going to be on the test?' Instead, learning goals are clearly spelled out so that students understand what they are expected to learn. The three teachers' classrooms in my study had not reached this level portrayed by Wiggins. But Marian and Lisa wrote their daily agendas on the board. Wiggins further stated that we see nothing out of the ordinary, in classrooms where assessment is taking place. This is not just the familiar sight of students busy at work, alone or in small groups. He argued that classroom sights where formative assessment is used are visually indistinguishable from what takes place during good instruction. But in this study, it was not as smooth sailing as Wiggins (1998) described. For example, Marian faced resistance from students, who thought that engaging in thinking activities was harder than listening to the teacher.

When teachers used embedded assessment, whether as envisioned by the originators, or their own interpretations of what it meant, their classrooms looked like social constructivists classrooms. What are the social constructivist perspectives on learning?

Social constructivists perspectives on learning

Applied to the classroom, social constructivism is a theory of knowledge and learning whereby students and teachers construct meaning and knowledge together (see Brooks & Brooks 1993). Teachers who work from a social constructivist perspective understand that students come to school with prior experiences and understandings that play a critical role in developing new understandings and, if voiced, are crucial to the development of new understandings in themselves and others. Such teachers structure ways for students to interact with one another. Beach defined social constructivism as:

> *A theory of knowledge that posits that people formulate knowledge by actively constructing that knowledge within specific social contexts or discourse communities, this theory challenges the idea that knowledge exists as an autonomous, objective entity. Constructivists posit that by actively formulating their own knowledge through talk and writing, students truly understand that knowledge. By formulating their own interpretations of a text, students are more likely to understand the meaning of that interpretation than if they restate their teacher's or a critic's interpretation. (1993, p.163)*

We have seen that Marian, Lisa and Sarah were having students talk and they were listening carefully. This is not common in most traditional classrooms, where the teacher dominates the talk and the students listen and are passive. Clark, writing about shaping education classes from a constructivist perspective, emphasized the 'mutual influence' students have upon one another in such environments:

> *Individual learners will inevitably interpret what they read, write, see, hear and feel using their pre-existing personal sense making frameworks. At the same time, learners will mutually influence the sense each makes of their common experiences. Discussions, presentations of work in progress, conversations, reading and responding to one another's writing, are opportunities for socially shaping, modifying and broadening the perspectives of individual learners (1997, pp 8-9)*

Clark makes an important point: Individuals will make their own personal sense of what they encounter. Teachers like Marian and Lisa, who designed their classroom activities to include interaction and collaboration, create opportunities for individual learners to mutually shape one another's personal understandings, to stretch and broaden these personal understandings. Learning was enhanced in Marian, Lisa and Sarah's classrooms. Marian believed that because she allowed students to talk and she listened to them for gauging reasoning, she was able to help where student understanding was incomplete. It also helped with value, self-esteem, increased participation and better behavior.

What I see as the difference between embedded assessment and social constructivism

For me, social constructivism is a *theory* about how people learn. It explains that people learn by constructing meaning within social contexts. Embedded assessment is a *tool* that enables teachers to teach in a social constructivist manner. For example, in my study, teachers encouraged exchange of ideas among students in classroom discussions. They structured their questions so that the students would answer in a way that exposed their meaning making. Marian described the questions well by referring to them as 'thinking or learning' questions. Embedded assessment helps teachers to see the evidence of their kids' learning and it is a tool that helps teachers to focus on student thinking. The reader should be clear that this claim about the relationship between embedded assessment and social constructivism is based on inferences only and not on actual data, it is therefore speculative. More research needs to be done to fully understand it.

Summary of the discussion of embedded assessment in classrooms

In this discussion, I have argued that description of embedded assessment in practice is an incomplete presentation, because of the complexities of teaching. Some authors have argued that classes that use embedded assessment are similar to classes that have good instruction. I have also speculated or inferred that embedded assessment is a tool that helps teachers to structure their lessons so that their students learn in a social constructivist manner.

3) Impact or influence of embedded assessment

The impact of embedded assessment will be discussed along the lines of the following strands: a) curriculum, b) students, c) teaching d) assessment and e) planning & reflection

a)Curriculum

Of the three teachers, Marian's views about the curriculum were influenced by embedded assessment. Like all other teachers, Marian used her curriculum materials to plan for her lessons. But after embedded assessment, not only was Marian using her curriculum materials to plan for her lessons, but also she was considering how to adapt her curriculum to fit her students' needs. What does it mean to adapt curriculum to fit the needs of students? She was not asking what should I cover next, but what did my students do yesterday and how can I help them with concepts that they did not understand? Marian was focusing on the key ideas; for example, for the ecosystems unit, Marian's key ideas were; the interactions among populations fall into common patterns, ecosystems tend to change over time, and people use and benefit from many plant and animal materials and therefore affect the environment. This is different from having discrete pieces of facts and covering what is on the curriculum. It was Bruner (1977) who restated the importance of a spiral curriculum and starting your teaching from where the child is. So, the impact of embedded assessment on Marian is in how she was packaging her curriculum. It took a longer time for Lisa to package her curriculum in ways similar to Marian because she believed in covering the district curriculum. Towards the end of the study, Lisa was concerned about helping students with their weaknesses which is different form just covering the curriculum. Sarah was limited by her subject matter knowledge in restructuring the curriculum.

b) Students

The three teachers' students came from low and lower middle social class families. Marian, Lisa and Sarah reported that their students had outside school factors that impeded their success at school. Cusick (1992) argued that society with all its class and cultural differences shows up in school where it faces the teacher everyday. Cusick said that "onto this microcosm of society the teacher has to impose the society's narrow definition of appropriate behavior."(p.33) Cusick wrote that the overlapping of school and society takes place in the classroom as students and teachers meet and work out an accommodation between what the school calls appropriate and what the diverse classes and cultures call appropriate.

Marian is a product of a preparation program that promotes ideas of scientific literacy for all. She wanted to teach all her students and not just a few. She also wanted to teach for understanding. This is consistent with the reform documents, Science for all Americans (AAAS, 1989) and National Science Education Standards. (NRC, 1996).

The impact of embedded assessment on views about students was that Marian thought she had found a tool that helped her to reach most of her students. But to her surprise, some of her students, especially the ones that have been successful in school resisted teaching using embedded assessment. Why? They were not familiar with it and it was harder than what they knew how to do already.

On the other hand, Lisa started this project by stating that it was impossible to help all her students, especially because they came from unsupportive home backgrounds. She believed that she could not help all her students because there are so

many bad things that happen in their life that affects their performance in school. Yet the reforms in science education are promoting the slogan 'science for all' to highlight that teachers should help all students become scientifically literate. (AAAS. 1989; AAAS, 1993: & NRC 1996). This belief that students' socioeconomic status is the best predictor of students' performance needs attention. It appears that Lisa had given up on some of her students, due to the fact that they come from poor or dysfunctional families and they have many problems. Given this information, why should teachers like Lisa not believe that the net effect of teachers is more dependent on students' native talent and opportunity than anything else? This to me means that, these students are disadvantaged at school and at home from an early age compared to their counterparts who come from well to do parents.

Anyon (1981) found that there was a relationship between social class and school knowledge. She argued that the class structure is fluid and therefore students from different social class backgrounds are still likely to be exposed to qualitatively different types of educational knowledge. She found that teachers who work with kids from working class schools rarely used thinking pages in the textbook but concentrated on the basics, whereas students from executive elite schools concentrated on reasoning and problem solving skills. She believed that what counts as knowledge in the schools differs along dimensions of structure and content. It seems to me that, in Lisa's case, what counted as knowledge and how it was taught were influenced by her beliefs about her students. This raises issues about how scientific literacy will be achieved if teachers continue to believe that they cannot help all students. The prevailing stance in the reforms is that all students can learn and achieve scientific literacy. Furthermore, Sarason (1971,

1996) argued that educational change depends on what teachers do and think. Lisa's thoughts about her role as a 'director' presented a challenging stance at the beginning of the study.

After Lisa had tried some embedded assessment, she shifted her focus from seeing students with problems, to concentrating on helping them with school. Based on my years of experience in working with teachers, I have noticed a tendency for teachers to focus on things that are beyond their control, like family background. I have developed a stance that teachers should focus on what they can do rather than what they cannot control. This requires a shift in mindset. Lisa's shift was due to participating in this project. Lisa was now focusing on helping students learn. She was involving students more in class discussions. She was helping them with how to state their ideas clearly and writing their thoughts. It seems to me that when teachers use embedded assessment systematically it forces them to involve students more and to let them talk and share ideas. However, Sarah's stance about her students did not change throughout the study. The reasons why it did not change were based on the context of her work and her beliefs about the capabilities of her students. So, what? The change in perspectives about students will depend on the teacher as well.

c) Teaching

All three teachers reported that embedded assessment helped them to focus on the process of learning and teaching. Similarly, Bell (2000) found out that formative assessment approaches help teachers look more carefully and closely at students, their learning and work. Bell's model further expands on the process of teaching using

formative assessment. She reported that teachers in her study undertook two types of formative assessment. These are planned formative assessment and interactive formative assessment. The teachers' eliciting, interpreting and acting on assessment information characterize planned formative assessment. She pointed out that the three aspects of eliciting; interpreting, and acting are interrelated and mutually determining. The main purpose for which teachers said they used planned formative assessment was to obtain information from the whole class about progress in learning science. The assessment was planned in that the teacher had planned to undertake a specific activity (for example, brainstorming) to obtain assessment information on which some action would be taken. The teachers considered that the information collected, as part of the planned formative assessment was 'general', blunt and concerned their 'big' purposes. It gave them information that was valuable in informing their interactions with the class as a whole. This type of formative assessment was planned by the teacher mainly to obtain feedback to inform his or her teaching. In my study, Marian did not use the technical terms that Bell's teachers did, but she did what I would call planned embedded assessment by eliciting, and interpreting and acting on the information she got from her students.

The second type of formative assessment from Bell's study was the interactive formative assessment. Interactive assessment was that which took place during student-teacher interactions. It involved the teacher noticing, recognizing and responding to student thinking during these interactions. Interactive formative assessment differs from the first form (planned formative assessment) in that a specific assessment activity was not planned. The interactive assessment arose out of a learning activity. All the teachers in my study exhibited this type of assessment. Marian called this 'planning embedded

assessment on the floor,' meaning deciding what to do next during the moment of teaching. Marian thought that this was significant for her in that it helped her obtain teaching ideas based on students' ideas. Marian described this process as consisting of three parts that are connected, cyclical & ongoing. The parts are: 1) planning for embedded assessment, 2) doing embedded assessment in the classroom with a live audience (kids), and 3) adjusting lessons based on what happens with your live audience. The problem I have seen in most classrooms is that it appears that what is prevalent is step 2 but this is weakened by the fact that it is done sporadically and without phase 1 and 3.

A key finding was that all three teachers reported that embedded assessment was connected to teaching for understanding. For example, Marian reported that she was seeing a connection between embedded assessment and teaching for understanding, Marian started this project with a desire to teach for understanding and to help her students to connect what they learn and see coherence among lessons and situations in their life. Marian reported that embedded assessment was a tool she used to accomplish her goal of teaching for understanding.

Embedded assessment and teaching for understanding

Wiggins & McTighe (1998) have developed a multifaceted view of what makes up a mature understanding, a six-sided view of understanding. Specifying the particular achievement each facet reflects summarizes the facets. They argue that when we truly understand we:

- Can explain: provide thorough, supported and justifiable accounts of phenomena, facts and data.

- Can interpret: tell meaningful stories, offer apt translations, provide a revealing historical or personal dimension to ideas and events, make it personal or accessible through images
- Can apply: effectively use and adapt what we know in diverse contexts.
- Have perspective: see and hear points of view through critical eyes and ears
- Can empathize: find value in what others might find odd, alien or implausible
- Have self-knowledge: perceive the personal style, prejudices, projections and habits of mind that both shape and impede our own understanding (PP 44)

The teachers in my study had not reached this complete understanding of teaching for understanding. But it seems to me that the first three bullets were visible in their teaching, because they talked about applying knowledge to other situation and also making connections and explaining. Wiggins & McTighe (1998) argued that what follows for assessment should be to assess those six facets. I suggest that teachers should use dialogue or interaction to assess. They should use reiterative core performance tasks to assess whether understanding is becoming more sophisticated. Given the likelihood of misconceptions, Wiggins & McTighe (1998) argued that teachers should use tasks that will best evoke such misunderstandings. They also say that teachers should assess student theories along a novice expert continuum, not merely through task specific rubrics. I think that Wiggins and McTighe are bringing an important point here that will make assessment even more meaningful to the students and their parents. It gives a complete picture of students' understanding. Because grades do not tell much about understandings or learning, the continuum that the authors have suggested can indicate understandings of students. This way assessment becomes useful and meaningful. They go on to say that an

assessment for understanding must demand thoughtful and qualified responses to sometimes-unanswerable questions. This approach is the opposite of an assessment using unambiguous and non-problematic questions to test discrete knowledge. They propose that assessment should assess student control of the big picture, for example, that students can see the connections between the lessons, units and courses that Marian talked about. Therefore, the impact of embedded assessment on the teachers is that they saw it as enabling them to focus on teaching for understanding.

d) Assessment

Before embedded assessment, Marian's purpose for assessment was to grade and revisit concepts after a period of time had elapsed. But Wiggins (1998) argued that as long as assessment is viewed as something that comes after teaching and learning are over, we will fail to improve student performance in school. After Marian was introduced to embedded assessment, she tried her level best to assess daily. She saw activities as assessment opportunities. This means that assessment and teaching were happening simultaneously. It seems to me that the new goals of science education reform, and the new theories of learning and embedded assessment complement each other and should be woven together. This is a 'new' and developing argument or framework that I saw happening with Marian and the other two teachers. I will discuss this framework later in chapter 9.

But does using assessment improve student performance, as asserted by Wiggins (1998)? I do not have empirical evidence to support that claim, as that was not the focus of this study. But I would like to bring the attention of the reader to a study done by

William & Black (2000). The purpose of their study was to seek evidence on whether development of formative assessment raises standards of learning. They found out that there was a significant learning advantage for their formative assessment experiments, with effect sizes ranging from 0.4 to 0.7 these are remarkably large for any educational experiment. They further claim that slow learners showed the largest gain.

All the three teachers changed their views about assessment. Lisa used worksheets and fill in the blanks before embedded assessment and Sarah viewed 'assessment' as testing. After the project, the teachers saw different purposes of assessment. After exposure to embedded assessment, Lisa was encouraged to use open-ended questions to see how her students responded to such forms of questions. Lisa reported that she found out that most of her students had poor writing skills. They were challenged in putting their ideas on paper. Lisa then focused on helping them to write to express thoughts and stating their ideas clearly. This is what Fulwiller (1985) called writing to learn and writing to communicate meaning. He argued that open-ended questions allow students a 'fuller' measure of expression. He believes that writing to be tested is not the same as writing to learn or writing to communicate. He argues that testing serves the school and society; but learning and communicating serves the individual writer. He points out that good teachers use writing to help writers rather than simply measure them. But he says that such teachers are rare. His study report that 46% of total classroom time was spent on writing activities best described as mechanical. It seems Lisa, through the use of embedded assessment, saw that writing in science is important and she needed to help her students develop this skill. Writing, like reading is integrally bound up with nearly everything else in and across the curriculum. Fulwiller in

his (1985) study found out that recognizing the role of writing in learning caused teachers to change their whole pedagogical approach in the classroom. He said that knowledge itself was perceived differently; more personally, more like something to be constructed than already given. Fulwiller argued that for teachers to do this they must slow down cover less and look more closely at student expressions of knowledge. Lisa was focusing on this type of writing advocated by Fulwiller. Embedded assessment helped Lisa diagnose her students' difficulties. She found out that they were poor writers. Her instructional adjustment focused on helping students with writing. Therefore, embedded assessment helped Lisa to assess her kids' writing.

e) **Planning and Reflection**

The key finding under this strand is that embedded assessment gave teachers a concrete way to plan and reflect, because the planning and reflection were now focused on how the teachers could improve learning and teaching in the classroom, rather than on what should I do tomorrow. Stiggins (2000) suggested that teachers should reflect on the following questions continuously: Did my teaching strategy work? What evidence do I have to prove that it worked'? What other suitable strategies can I use? How is the pace and what do students need? As this study progressed, observations of the three teachers in the classrooms and during interaction with them provided evidence of development in asking these questions.

Summary of the impact of embedded assessment

Embedded assessment enabled Marian and Lisa to adapt their curriculum to fit the needs of the students. When teachers used embedded assessment systematically, it

required them to involve students more, to let them talk and share ideas during class discussions and among themselves. Teachers were thus becoming *investigators* of their students' thinking. They were *analyzers* of that thinking (inquiring into children's thinking) and they became *designers* of instructional strategies that helped to address student difficulties. This had a positive influence on some of the students. Embedded assessment enabled teachers to teach for understanding. Teachers changed their original views about assessment. Embedded assessment also gave teachers a concrete way to plan and reflect. It enhanced both teaching and learning.

4) Problems, challenges and tensions associated with learning and using embedded assessment

The problems and challenges discussed in chapter 7, are not new, neither is there anything surprising or intriguing about the problems that teachers talked about. A number of authors have discussed these, some since the 19th century (Liebermann & Miller 1999). Efforts to reform teaching are not new as well. They have a long history. The issues and concerns brought by teachers and their students represent what Liebermann & Miller (1999) called 'enduring tensions'. They have argued that if you introduce one 'new' thing in an education setting, all the inherent problems will appear. I describe this, as 'all hell breaks loose'. Why? Because the new ideas are being implemented in an old system of schooling. Cusick (1992) wrote about educational systems and argued that there are common and predictable elements within and across schools, which do not change. These are what make the educational system. What I have learned from the three

cases is that some of the teachers' inabilities to use embedded assessment were due to the fact that we have new goals of science education, and new tools like embedded assessment and new theories of learning like constructivism. The teachers agreed that all these were good and maybe better ideas about schooling, but the problem is that they were being implemented in an old system that was designed with old goals like producing scientists and seeing learning as acquisition of facts. These ideas were appropriate and fitted well in the system. I argue that we need to rethink the system of schooling. It will come only through radicalism, because if we look at systems that changed, they came through leadership and people that were radical about change. For example, changing the apartheid system in South Africa came through the leadership of Nelson Mandela who was a radical leader. I believe that as long as we continue with the school system we know now we will still continue with old methods of teaching and assessment.

The literature on teacher knowledge has put a compelling argument about the importance of subject matter content knowledge. The case of Sarah is consistent with Borko & Putnam (1990), Grossman (1990) and Shulman (1987) who argued that in order to teach in new ways (e.g., using embedded assessment), teachers need in-depth subject matter knowledge and they need to think in new ways about the curriculum. Strong subject matter includes knowledge of the content (key ideas, concepts, organizing principles) as well as the substantive and syntactic structure of the discipline (Schwab, 1978, Shulman 1987), which may lead a teacher to analyze the explanations, interpretations, discussions and written tasks in the process of using embedded assessment. Teachers in my study explained that strong subject matter knowledge enabled them to spot misconceptions, to see the bigger picture so you can guide the

students to that picture. They reported that it would be quite difficult for the teacher to use embedded assessment if their content knowledge was weak.

Teachers in my study complained that embedded assessment slowed down their pace of coverage of content. They complained that it was time consuming to teach using embedded assessment. Wiggins (1998) challenged this notion, as a faulty premise because he believed that coverage of content does not necessarily mean maximized test scores. He pointed that this view is unproven at best or completely false at worst. Wiggins (1998) further challenged the notion of time as a factor. He points out that the key to any successful assessment reform is not finding more time to do the same things. Rather, we need to redeploy the available time, mindful of new goals and working smarter with the time. He gives examples from his study, e.g., rearranging the schedules. He believes that learning is not optimized by content coverage. Marian complained about embedded assessment because she was not sure when was it time to move on, how many times to re-teach so that they completely understand. Marian was facing the tension of whether to cover content or to teach for understanding. The problem that Marian faced is a school system issue and we can see that even in the system, Marian was making choices or decisions that fitted her belief system. Bruce & Peyton (1999) argued that teachers are never passive recipients of new ideas, approaches; rather they are active agents in determining the shape of the new idea. Gardner in Wiske (1998) argued that focusing on coverage rather than understanding leads teachers to revert back to traditional ways of teaching and assessment. Therefore, Marian faced the problem of coverage versus understanding because embedded assessment enabled her to focus on understanding.

Ball (1995) argued that the slogan 'teaching for understanding' or 'science for all' were highly complex when viewed up close. I would add that teaching using embedded assessment is complex too. Ball believed that this was so because teachers' work with and 'on' other human beings and such work are interdependent in ways that make it clearly different from working with plants, for instance. Teachers cannot entirely control students. All the three teachers felt that there was a need to 'train' or model various aspects of embedded assessment, otherwise there would be frustration for the teacher and the students. This perspective is consistent with Fullan (1991) who pointed out that teachers who blend education and change, periodically discuss the meaning of activities with students, work on the skills students need to participate in new educational reforms, and believe the relationship between the new and old will have better results. Embedded assessment was complicated by what Ball (1999) stated as the particular nature of teaching. She argued that teaching occurs in particulars, particular students interacting with particular teachers over particular ideas in particular circumstances. No amount of knowledge can fully prescribe appropriate or wise practice.

Embedded assessment caused teachers to be overwhelmed, overloaded with too much work, and frustrated because of all the challenges they had to deal with. Perrone (1991) argued that many people view the movement toward a different type of assessment as a difficult, enigmatic process that demands too much from teachers. But he believed that these different assessments benefit not only the students but also teachers. Once teachers begin such efforts, the difficulties fall away and their work becomes easier. I agree with Perrone on the point that it benefits the teachers and students, but I disagree on the stance that it becomes easier. Why? Because teaching using embedded assessment

is hard given the conditions under which the teachers work, i.e., the school system makes it hard, for teachers like Marian to do embedded assessment. Cusick (1992) argued that even though times and people change in education, the problems and solutions recurred because the system of schooling does not change, this is consistent with my perspective. Fullan (1991) pointed out that the status quo is so fixed that it leaves little room for change. This brings again my argument that there is need to rethink the system of schooling. I do not have an answer for how to do this nor do I prescribe a solution, but I invite the reader to consider further exploration, and research. Also, I am aware that it is not only changing the system that will bring about change, because I have also discussed that the teacher beliefs and students will influence the outcome of the project. Therefore, educators need to work on changing teachers' beliefs, knowledge and skills because we have seen in this study that teachers using embedded assessment can make a difference in student learning and motivation even with the limitations and constraints imposed by the system.

Summary of the discussion chapter

I have discussed the way the three teachers in the study made sense of embedded assessment. I have stated that it is a complex process influenced by the teacher beliefs, skills, and the context of use. Embedded assessment was difficult and challenging for both teachers and their students. Two teachers in my study redefined the meaning of embedded assessment in a 'new' compromised meaning. I have also argued that my descriptions of what embedded assessment looks like in practice are actually an

incomplete presentations because of the complexities of teaching. I have inferred that embedded assessment is a tool that helps teachers structure lessons so that students can learn in a social constructivist manner. Embedded assessment influenced the teachers' perspectives about curriculum, students, teaching, assessment, planning and reflection in ways that were beneficial to the teacher and students. I have also discussed that this project was not easy and smooth sailing for teachers. It had its own challenges, dilemmas and tensions. Throughout the cross case analysis (chapter7) and this discussion chapter, I have highlighted and pointed out to the reader that I have developed a framework, to, which I turn next.

CHAPTER 9

CONCLUSIONS AND IMPLICATIONS

My own conceptualization of learning and teaching using embedded assessment has deepened and grown as a result of this study. The diagrams (Figure 9.1 and 9.2) show my current thinking in relation to the bigger picture of my study. The diagram of the new model of science education goals, embedded assessment, teaching and learning is a work in progress. It is based on the literature and, throughout the cross-case analysis and the discussion of my findings, I have pointed the reader to it.

What I have shown and argued for in this study is that learning and teaching using embedded assessment is difficult and complicated. My sense making of the complexity and the models that I have developed are grounded in the findings of this study and theoretical roots in research on: assessment, educational change and innovation, reforms in education-science education reforms, teacher learning and change, professional development, constructivism, and teaching for understanding. While I do not believe that recipes or prescriptions or formulas for teaching and learning arise from this study, I do believe that educators and parents can learn much from Marian, Lisa and Sarah. I believe that the case study chapters help illuminate how teachers made sense of embedded assessment, what teaching using embedded assessment in the middle school classroom looks like, and the benefits and challenges of using embedded assessment.

This study has offered me a number of lessons from which others in the education community can benefit. In this chapter, I will explore several of the lessons which members of the education community (teachers, educators and theorists[1]) can take away

[1]I use the name theorists to refer to educational researchers and writers of education literature. My findings also speak to parents as well as students. I will look at implications for teachers, teacher educators, theorists, curriculum designers, professional development,

from this study. But first, I will address lessons learned about embedded assessment and science education.

Lesson Learned: Embedded assessment, goals of science education reforms and 'new' theories of learning (mainly constructivism) are interconnected and entwined but the problem is that this new framework of science education is enacted in an old system of schooling. This makes the framework incompatible with the standard operational modes of schooling.

Before I discuss the incompatibility of the new vision of science education and the standard operational mode of schooling, I want to show the reader how the old goals of science education, old views of assessment and theories of teaching and learning fitted the standard operational modes of schooling. It was all well packaged. For the historical perspective, I draw upon the works of Bybee (1997) in his book achieving scientific literacy. (For this discussion refer to the Figure 9.1: old models of goals of science education, assessment, teaching and learning).

The historical framework components are familiar to most readers in science education. I argue that the traditional views of teaching, learning and assessment and the goals of science education in the 1960's were tightly connected and that they fitted the school system. The goals of science education in America in the 1960's were to attract academically talented students who were going to pursue careers in science. This meant that science was for the privileged few. These students were expected to compete for scientific superiority with the Soviet Union. Assessment during this time was used to sort students. To find the academically talented, IQ tests and school grading were used to sort students. We know from literature on teacher learning that assessment drives the kind of

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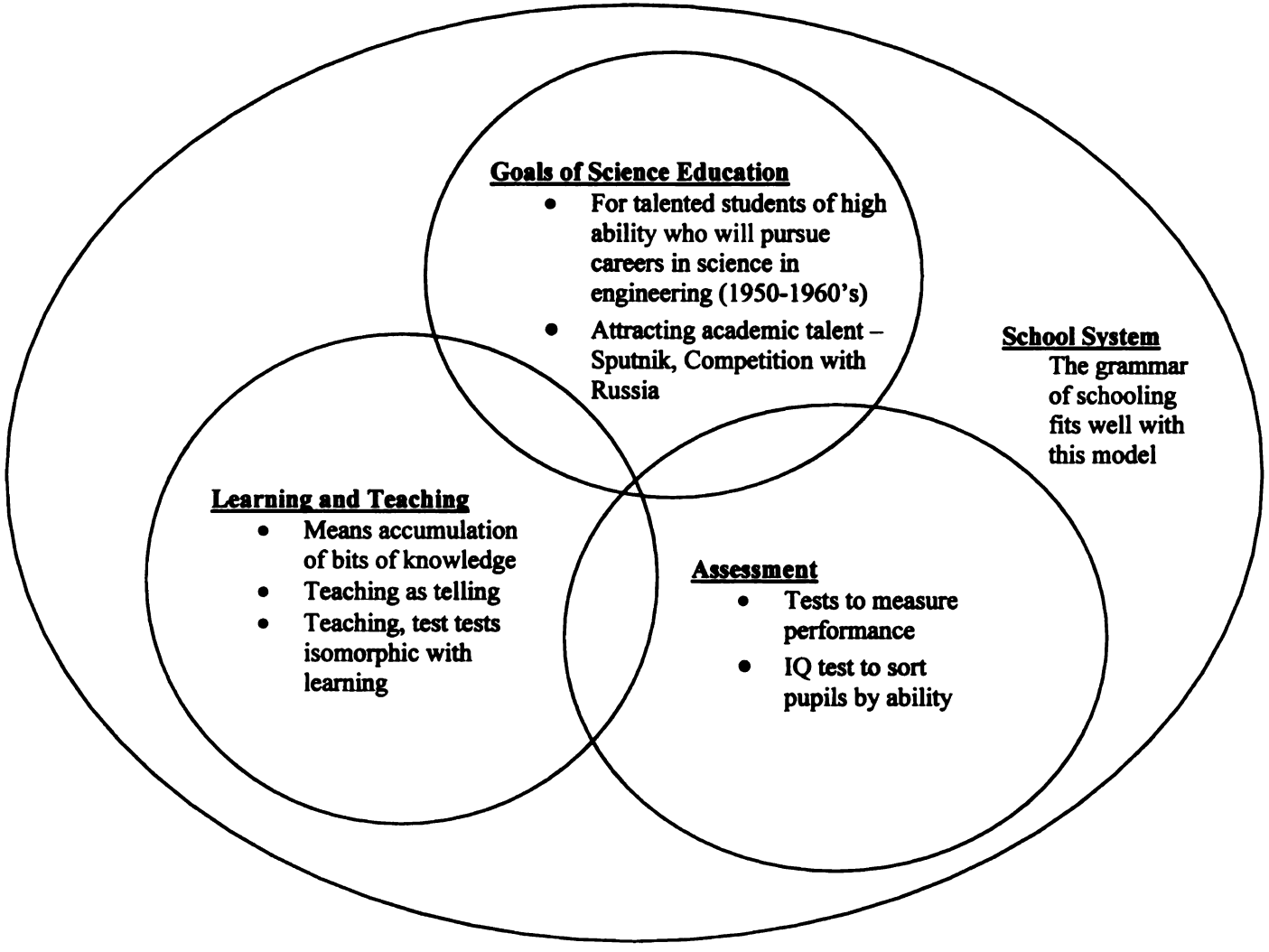
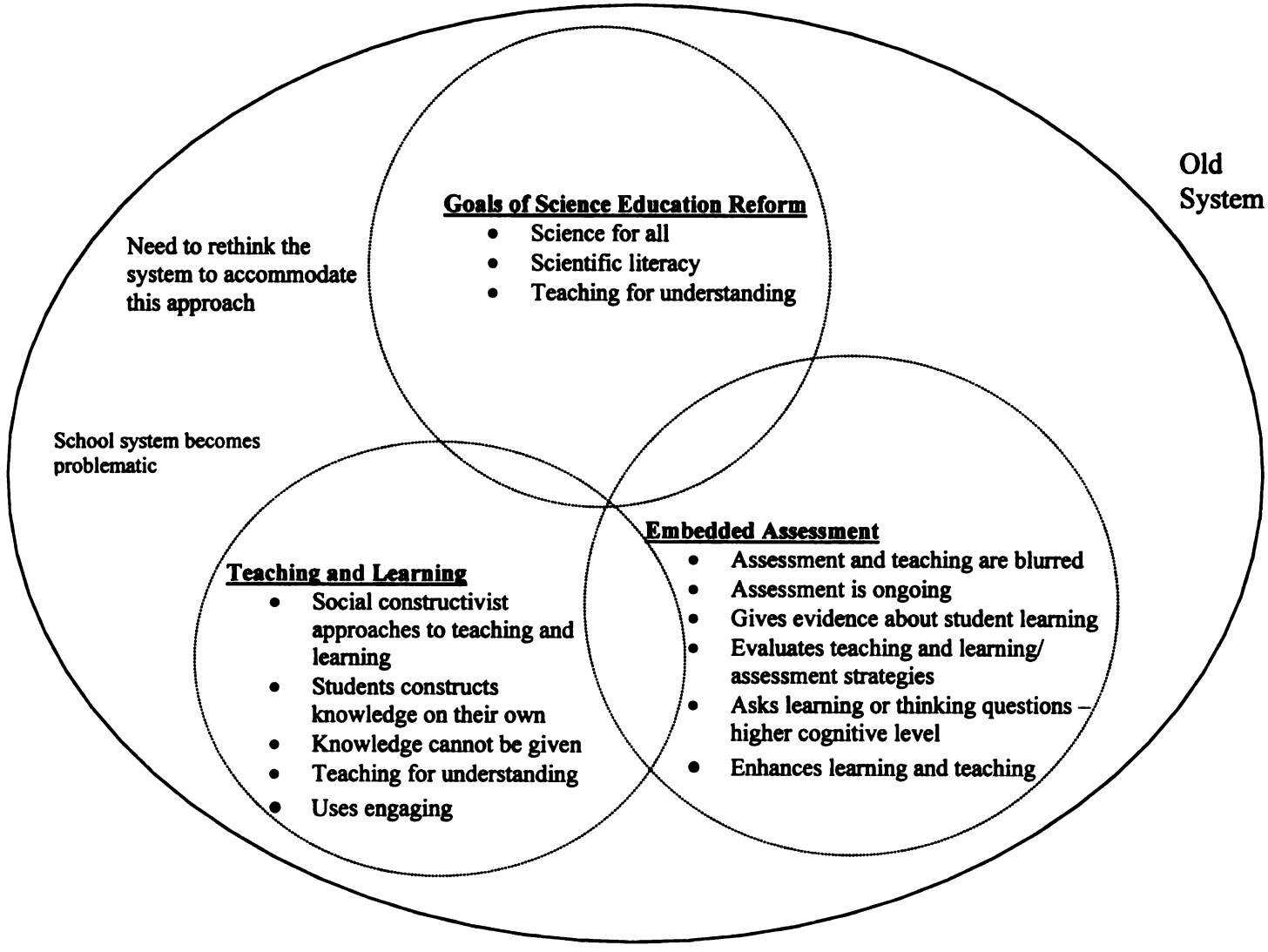
science education reforms, parents and students.

Figure 9.1. Old Model of Goals of Science Education, Assessment, and Teaching and Learning



Interlocking Tenets of Goals of Science Education, Assessment and Learning

Figure 9.2. Letina's Model of Goals of Science Education, Embedded Assessment and New Theories of Learning and Teaching



Interlocking Tenets of Goals of Science Education, Embedded Assessment, and Teaching and Learning

teaching and learning that takes place in the classroom (Elmore, 1988). The type of assessment during this time was an official event (Bliem & Davinroy 1997) separate from instruction. The assessment emphasized rote recall, and multiple-choice tests were the most common. Because of this, teaching meant telling and learning was accumulation of bits of knowledge. Tests were given frequently to ensure mastery. Tests were isomorphic with learning. This worked very well with the way schools were organized. That is, the teacher was a giver of knowledge, so the number of students in the class was not a problem. Students were passive recipients of information. By using these methods, teachers were able to "cover" a lot of science content. This model worked well what Tyack & Cuban (1995) call the grammar of schooling.

They argued that as long as the grammar of schooling persisted, fundamental change would not be attainable. The grammar of schooling is the way schools divide time and space, classify students and allocate them to classrooms, splinter knowledge into subjects and award grades as evidence of learning. Patterson (1993) has argued that the behavior of individuals in a system is dictated by underlying structures and to him this would explain why Lisa and Sarah in my study redefined embedded assessment. It is the systemic challenges that caused Lisa to alter the original conception of embedded assessment.

In the dawn of the 21st century, there are new goals of science education. These goals are science for all, teaching for understanding, less is more, and a broadened spectrum of science (AAAS, 1989; NRC 1995). Teachers in this study were responding to the new goals of science education. In this study, the teachers reported that they were focusing on helping kids construct meaning about scientific ideas. They also allowed

students to talk and show their understanding. This to me was a description that pointed towards a more constructivist approach towards learning. Teachers talked about identifying students' naïve conceptions and addressing those. Teachers used embedded assessment to teach this way. Therefore, this meant that there was a connectedness and intertwining (see diagram: new goals of science education, embedded assessment and new theories of learning and teaching) of the three parts, i.e., goals of science education, embedded assessment, and constructivism. Shepard (2000) argues that:

> "If instructional goals include developing students' meta-cognitive abilities, fostering important dispositions, and socializing students into the discourse and practices of academic disciplines, then it is essential that classroom routines and corresponding assessment reflect these goals as well. This means expanding forms of data gathering to include observations, clinical interviews, reflective journals, projects, demonstrations, collections of student work and peer evaluations and it means teachers must engage in systematic analysis of the available evidence." (p.8)

Marian, Lisa and Sarah used most of the assessment strategies Shepard (2000) describes. They used assessment to investigate students' understandings of scientific phenomena and gathered and analyzed student work as evidence of learning. In this way assessment was blurred with teaching.

Teachers in my study reported that they were experiencing problems, for example, the number of students they teach made it impossible to help each child reach optimum understanding. They found it was difficult to cover the objectives in the district curriculum because of time constraints. They lacked time to do more with their students and to push them further in understanding science. The block scheduling affected what they could do in fifty minutes. Tyack & Cuban (1995) argue that it is this grammar of schooling that inhibits change.

As shown in the diagram figure 9.2, new models of goals of science education, embedded assessment and new theories of learning and teaching I argue that embedded assessment, goals of science education and new theories of learning (constructivism) are closely intertwined and connected. I also argue that if we are to use this model of science education we must help teachers, administrators, students and parents by changing their values, beliefs and skills because without changing their belief system, the system cannot change. By changing their beliefs, values and skills the sytem might be able to change. Therefore, it is changing both the beliefs and values as well as the sytem that will bring about change. Teachers in my study saw the system as an obstacle for using embedded assessment effectively. We are enacting a vision of science education in a system that was structured for the very things that we are trying to change. We need to have a multiple faceted focus in bringing about new ideas in the schools. These should include examining the grammar of schooling, teaching, learning, teachers and their beliefs, and students. But what does it mean to rethink schools? I am not arguing that schools should be restructured because I know from the literature on school reform (Tyack & Cuban 1995; Fullan, 1991) that solutions to one problem may lead to other problems and even worsen the problems we are trying to solve. I think we need to re-examine and think carefully about schools as a system. But what that may entail is open for investigation and exploration. Additional research is needed to examine the models I have used in this discussion, because the arguments were based on data from only three teachers in one school district. More research is needed to either refute or add to the models, or to refine them.

Lessons learned: Teachers can learn about embedded assessment from Marian, Lisa and Sarah and envision what they might attempt in their classrooms

Teachers can learn much from Marian, Lisa and Sarah. Seeing what others have done within their own contexts can help teachers envision what they might attempt in their own. Seeing three different teachers take three different paths for enacting embedded assessment is helpful. It communicates that there is not a single right way. But at the same time it can be problematic, as it sends the message that you can make it what you want it to be. This may result in the lack of a common language that carry common understandings. Teachers can read the case studies of Marian and Lisa and imagine what teaching using embedded assessment in middle school science may look like. The case studies are in no way templates. However, teachers can learn from the underlying principles or frameworks of embedded assessment. The challenges Marian, Lisa and Sarah experienced as well as the risks they took are likely to promote teaching for understanding (Wiske, 1998).

Teachers can learn the benefits of using embedded assessment in their classrooms. They can also examine the challenges that these teachers faced and design strategies to counteract those well ahead of time. The case studies can also inspire others to reflect about their own assessment practices.

Lessons Learned: professional development must be long term and provide in school observation and support

We have seen that embedded assessment is a useful tool that enhances teaching and learning. Teachers in my study reported that there were improved classroom interactions. They were getting more effort put into classroom activities and assignments from kids than before. Embedded assessment gave Marian and Lisa concrete evidence about their students' learning and understanding of scientific concepts. Even though embedded assessment was hard and presented pragmatic challenges, the ultimate beneficiary was the student. Teachers also benefitted because it improved their analytical skills, listening skills, and their teaching and assessing repertoires. Science teachers and even teachers in other subject content areas need to be aware of embedded assessment through professional development opportunities and encouraged to use it systematically, because if it is used sporadically, the effects are minimal.

The case of Lisa illustrated the need to be present in teacher's classrooms as they try new ideas. Firstly, this not only informs professional developers about how this plays out in practice, but it changes the discourse in the professional development sessions. The discourse becomes embedded in classroom work. It becomes a reflection of improving the 'new' idea in practice. Secondly, we have seen that Lisa would have given up without my intervention; if I had not been in the classroom, I would not have been able to give her plausible suggestions. This did not just encourage Lisa to continue in the project, but it resulted in a turning point in the project, in her teaching, and in the type of learning in her classroom. Following up teachers in the classroom is not a new idea. Previous research on professional development points has alerted us to this important component. But my study gives insights on the specifics of why it benefited Lisa. The professional

development was not a just one shot workshop but it was continuous throughout the study. So, this study's findings are consistent with literature on professional development.

Loucks-Horsley et al (1998) and Stiles and Hewson (1996) have asked a significant question: There exists a strong knowledge base and indeed a consensus about effective professional development, but why is there a gap between knowledge and practice? One major reason they gave is that there is a lack of rich descriptions of effective programs and knowledge of effective professional development strategies and structures for teachers of science. In addition, there is no one place where guidance about how best to assist teachers in their professional growth can be found. The case of Lisa shows what led to her growth and the strategy used. But one thing that I learned about professional development is that I should never forget that I am working with human beings who have different personalities. How you work with them has a direct influence on the success of the project.

Lessons Learned: Embedded assessment must be an integral part of teacher education

I have suggested that embedded assessment needs to be taught to inservice teachers through professional development. All the teachers in this study reported that assessment was one of the weakest areas of their teacher preparation or that it was not covered in an in-depth way. So, embedded assessment needs to be taught, modeled and coached for pre-service teacher candidates, because it helps them learn how to teach for understanding, it helps them become teachers that achieve the contemporary goals of

science education. It helps their students learn in non-didactic ways. It also helps teachers focus on kids' reasoning about scientific concepts.

Marian, a beginning teacher, was a success in this project. Her story illustrates the importance of supporting beginning teachers. The embedded assessment project was a support for Marian. It enabled her to pursue ideas she had learned in her teacher preparation program. It scaffolded her teaching in ways that would not have otherwise happened. Lortie (1975) argues that the induction into teaching is not highly developed, because a beginning teacher is fully responsible for instruction from her first working day, performs the same tasks as the veteran teacher, and receives no interpersonal support. The embedded assessment project gave Marian tools for meeting goals she already had for her students and for pursuing ideas she had learned in her teacher preparation program. This study shows that there is a need to support and develop induction programs, because we know from the research on teacher learning that beginning teachers are discouraged from implementing the ideas they learned in their preparation programs. They become part of the school system and teach like their colleagues.

The teachers in my study believed that strong subject matter knowledge was needed to do embedded assessment well. So, this is consistent with literature on teacher education. Teacher educators need to address the way subject matter knowledge is learned at college. Does it prepare teachers to teach specific grade levels? Does it help teachers adjust the science content learned at college to suit the level of students they will be teaching? Teacher educators need to teach pedagogical content knowledge because

this is related to embedded assessment, which involves teachers choosing appropriate strategies to adjust instruction.

Lessons learned: Theorists should be more in touch with schools, teachers and students

This study reveals the need for theorists (educational writers and researchers) and policy makers to get into the classrooms, watch closely, and listen to teachers and students. Often theorists spend little time in the classrooms of the teachers they write about or write for. To genuinely understand a teacher's practice and students' learning, careful and extended observation must occur. But even when this happens, researchers can never fully know the teaching and learning that occurs every day.

I have pointed out issues that need further study, e.g., the three part model I developed, and the study of what leads to turning points for teachers. Most of the problems that teachers talked about were systemic problems. So, we need to rethink schools and to come up with solutions to these problems. Solutions that will make using embedded assessment less frustrating and less overwhelming for teachers. These solutions will need to be more than an'add-on' or a fad.

We need further research to understand what this type of assessment (embedded) means for students, e.g., what is the effect of embedded assessment on learning and on students' performance on standardized tests? Teachers in my study believed that if this link could be shown, then most teachers will be prepared to make it part of their practice, and it would be easy for them to sell the idea to colleagues in their schools.

Lessons learned: Curriculum developers should respond to new instructional modes that include teaching for understanding, embedded assessment and less is better.

All three teachers reported that embedded assessment slowed down their pace of content coverage. We have learned from the TIMSS (1997) (Third International Math & science studies) that the USA curriculum covers more compared to other countries. Findings in the TIMMS study are consistent with what Marian, Lisa and Sarah reported. Curriculum developers need to reconsider the slogan 'less is better' or 'less is more' to enable teachers to teach for understanding. Some of the teachers in my study stated that they would feel guilty if they do not cover the curriculum.

Lessons learned: Informs the science education reformers about how embedded assessment plays out in practice

Teachers reported that embedded assessment helped them teach for understanding. In doing so, the teachers reached a larger number of students than before. Therefore, the work on embedded assessment gives teachers a tool to achieve the goals of teaching for understanding, part of the national science education reform agenda. It has informed the reformers about the challenges teachers faced as they tried embedded assessment. Now, the community can begin to think of ways of addressing those problems. This study has informed the science education community about how reform ideas may play out in practice. Now it is up to us, the science education community to nurture the compassionate genius within each of us and come up with plausible solutions. And who will spearhead this work? Perhaps each of us can contribute and become generators of change. Further, we need to educate new science educators who will

spearhead this work. We will need the efforts of reformers in many levels of the school system, in order to bring about the change we seek.

Lessons learned: Parents must understand embedded assessment and its place in effective science teaching

Teachers in this study complained abut lack of support from home. They believed it was equally important for parents to understand embedded assessment so they can see its benefits and challenges. This will enable the parents not to resist change but to support it. Parents need to understand embedded assessment and be informed about the education of their children. As a parent myself, I can attest that we cannot leave it all to the teachers. We must play a significant role, a deeper role than just trivial, in understanding current research in education. Maybe we can be an additional force that can bring about change in the schools.

In a similar way, students need not to leave their education totally in the hands of teachers. They need to support new ideas that may make learning more meaningful to them. They need to be a voice that can inform us about their experiences in school.

To summarize, I have presented the conclusions to my study in the form of a model or framework, as well as in implications for the various members of the educational community. This model is in its infancy stage. I have argued that it is open to criticism and revision, but it has made me crystallize the kinds of issues in my study. I have suggested that this framework needs to be developed and tested empirically. I have given implications of my study for various stakeholders. Now it is up to us to be the change that we want to see happening because all of us are connected to schools.

APPENDICES

PRE ASSESSMENT INTERVIEW QUESTIONS

Before these questions, introduced myself, that I was a middle school science teacher and my major was biology. I taught middle school science for three years before going to graduate school. I gave the teachers more detailed information about myself. This was done strategically to make the teachers feel at ease about working with me and about talking about themselves as well. Interview one was done after observing the teachers for a week three times. This was done so firstly, so we could draw on common experience but also that I can analyze what the teachers' practices were before they learned about embedded assessment. I also thought that one week would give us enough time to get acquainted to each other. I also found that this was necessary for building trust and rapport at the start of the project.

(INTERVIEW 1)

1. Tell me about yourself, background and how long you have been teaching science?
2. Why did you choose to teach science?
3. What is good teaching or best practice from your perspective?
4. Where did you get your teaching certificate?
5. Who has had a profound influence in your life? Explain why and how?
6. What is the role of the teacher/student in your class?
7. What assessments do you use in your classrooms?
8. Have you ever heard of embedded assessment, classroom based assessment? What does it mean to you? Do you use in your it classroom now? If so, give a description.
9. Do you use embedded assessment in your teaching?

10. What strategies do you use in teaching science? What kind of activities do you use in your teaching and why?
11. What kind of things do you consider when planning a lesson/unit? Describe your planning process.
12. What are you hoping to learn from this project?
13. What made you volunteer to participate in this study?

Interview # 2 guiding questions

1. What is your reaction to the professional development sessions that we just had? What was helpful, confusing, difficult and new?
2. Now that you have learned about embedded assessment, what things would you do differently in your class?
3. Tell me how the professional development session has altered your thinking if at all?
4. In your own words, what does embedded assessment mean? What is the key points that you learned?
5. What things would you consider doing differently in your teaching and why?
6. What things are you struggling with about embedded assessment and this study as a whole?
7. What kind of support do you think you need as you try embedded assessment in your classroom?
8. How will you use the ideas and practices, which were introduced in the professional development sessions?

9. In our next professional development: what do you recommend we should do that best suits you and serves the needs of students?
10. How are you going to use embedded assessment in your classroom?

Consider the following:

- Planning, teaching and assessment
- Students
- Strategies
- Reflection

Interview # 3

- How confident are you in teaching the unit on ecosystems?
- Are you doing anything different in your teaching since you learned about embedded assessment, if so tell me about it and say more about how that is developing, if at all?
- What teaching strategies are you using to re-teach concepts and why do you choose those?
- Have you noticed any changes in your classroom since you learned about embedded assessment?
- Has your role and or students' role changed? Are you asking students to do anything differently? If so, describe.

6.Tell me about the things you have done or plan to do that involve embedded assessment? How did that go?

- Does using embedded assessment make a difference in your class? Explain.
- How does the information on students' difficulties help you as you think about teaching?
- How do the students' difficulties guide your planning and teaching if at all?
- How many times do you teach a concept?
- What determines how long you will spend on a particular concept and or objective?
- Are you aware of students' difficulties for the unit you are teaching on ecosystems? If so, how do you use this knowledge?
- How has your teaching/thinking changed since getting involved with this study?
- What challenges, problems have you faced so far as you have been trying some embedded assessment in your teaching?

Interview # 4

1. What is your reaction to the professional development? Did you find it useful/useless? If so explain in what way? If not explain what would be most useful to you and why?

2.In the meeting you talked about...eg brain research, can you talk more about that and how you see it linking to this project? What things are you going to do differently and why?

2. Since you learned about embedded assessment, what kind of things have you tried in your classroom and describe how it plays out in your classroom?
3. Is this project influencing your thinking and practice? Your perspectives about students, learning, assessment, teaching, planning and reflection?
4. What things are still fuzzy in your mind about this project and embedded assessment?
5. As you look ahead in the next few weeks: how will you incorporate embedded assessment in;

- planning
- classroom

6. In the professional development meeting, you talked about student misconceptions (this was specifically for Lisa) how are you going to address these and how did you know about them?
7. Describe how you handle student work and give details.
8. Comment about the discourse in your classroom?
9. As we think about our next professional development, what kind of things would you like to see addressed?
10. What kind of things are you struggling with in the professional development session in your planning and teaching using embedded assessment?
11. Your views about teaching, learning and assessment, have they changed?

Interview # 5

- Mostly similar questions as asked before

Interview # 6

1. What impact has embedded assessment had on your teaching, classroom environment and your students?
2. What was the most difficult aspect in using and learning about embedded assessment?
3. How has your practice changed since getting involved in the embedded assessment project?

- Planning
- Analysis of teaching and student learning
- Questioning
- Views about teaching, students and learning

4. Overall what do you think you have learned from this project?
5. What was difficult about using the embedded assessment approach in teaching science to middle school science?
6. Would you recommend your colleagues to use embedded assessment in their teaching? If so, why? If not why?

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