AN ABSTRACT OF THE

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FRANK L. HOLMES for the degree of Doctor of Philosophy in Science Education presented on May 2, 2003.

TITLE: <u>Middle School Science Teachers' Personal Growth and</u> Professional Development: What Do They Mean?

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Norman G. Lederman

A teacher may say, "I have twenty years of experience," but just what does it mean? This study suggests explanations for the meaning of "Experience," not by looking at the number of years in a classroom, but at what teachers did in those years that could make the teaching experience equivalent to years of personal growth and development.

Three Middle Level Science teachers' experiences were observed over two separate units of instruction. Teachers were engaged in conversations before, during and after every observation, such that their talk gave meaning to teaching. The teachers, early in their units, experienced tensions (stresses and anxieties) that affected their planning and implementation of teaching. The study determined that the teachers' learning experiences and personal growth were directly related to how they met the challenge of tensions. One teacher with very little science knowledge met the challenge of tensions in teaching by integrating her new science knowledge with her English and History knowledge and repertoire. She developed new practices that increased her energy and confidence in such a way that became selfsustaining experiences and growth.

Two other teachers, despite science backgrounds, were less successful in meeting the challenge of tensions in teaching. Each found that the contents of the selected units required study and preparation, yet the teachers acquired information rather than truly learning the new subject matter. These teachers, in meeting the tensions of teaching, felt their energies wane, which reduced their dedication and effectiveness. As a result, neither teacher experienced personal growth. The negative experiences resulted in each teacher becoming more entrenched in a lecture mode of teaching to escape the tensions that existed.

Learning new subject matter can produce tensions leading to experiences which affect teaching and potential for teacher growth. Incremental amounts of growth are possible, but only if a teacher responds positively to and meets the challenge of tensions in teaching, minute by minute, class by class. ©Copyright by Frank L. Holmes May 2, 2003 All Rights Reserved Middle School Science Teachers' Personal Growth and Professional Development: What Do They Mean?

Ву

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I understand that my dissertation will become part of the permanent collection of Oregon State University libraries. My signature below authorizes release of my dissertation to any reader upon request.

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Frank L. Holmes, Author

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Middle School Science Teachers' Personal Growth and Professional Development: What Do They Mean?

CHAPTER I

It always seemed to me that the ability to think critically and creatively is the prime cause for every important discovery that man has made. Albert Einstein (1938)

Introduction

Clark and Peterson (1986) found that many investigators collectively described teaching as an extremely demanding and uniquely human endeavor. Other researchers have reached the same conclusion for teaching in the middle-level science classroom (Carnegie Council on Adolescent Development, 1989; 2000; Irvin, 1992; MacIver & Epstein, 1991). Middle-level teachers require an understanding of the behavior of adolescents (11-13 years old) and the ability to create a thinking and learning atmosphere. Turning Points (Carnegie Council on Adolescent Development, 1989) and Caught in the Middle (California State Department of Education, 1988) charted the evolving needs of middle-level students and declared that most middle-level teachers are initially illprepared to meet the challenges of teaching. Eleven years later, Turning Points 2000 (Jackson & Davis, 2000) still maintains that middle schools require teachers who are expert in teaching adolescents and engage teachers in ongoing, targeted professional development opportunities. Scales

(1992), in a national survey, found that the majority of middle-level teachers were elementary or high school trained (Valentine & Mogar, 1992). Such education programs did not address the special needs of middle-level science teachers. Middle-level teaching is predicated on a set of practices designed for the 6th-8th grade levels (Irvin, 1992). Such practices include the use of advisory groups, school transition programs, interdisciplinary teaching teams, and special exploratory courses (MacIver & Epstein, 1991). Further teachers of the middle level "rarely have the training and experience needed to develop curriculum, assessments, and instructional activities that are sufficiently rigorous to promote effective student learning" (Jackson & Davis, 2000, p. 223).

As a consequence, practicing middle-level science teachers have evolving personal growth and professional development needs. Studies show middle-level science teachers require development, both professionally and developmentally, because general education programs do not address the uniqueness of middle-level students and their adolescent needs (Scales, 1992; Straham, 1993). The National Science Education Standards (National Research Council, 1996) and National Certification Association for Teacher Education (1996) declared that (1) beginning middle-level science teachers are weak in content and professional knowledge, and (2) professional development remains a pressing need for practicing middle-level science teachers. The National Research Council (NRC, 1996) has defined these needs in

professional development standards: learning essential science content through the perspective and methods of inquiry (Professional Development Standard A, (PDS-A); building understanding and skills for lifelong learning (PDS-C); and providing professional development programs that are coherent and integrated (PDS-D). <u>Turning Points 2000</u> (Jackson & Davis, 2000) specifically suggested that effective professional development in middle grade schools is resultsdriven, standards-based, and embedded in teachers' daily work (Sparks, 1996, p.2).

Lieberman (1995) asserted teachers (all levels) are unaware of their importance in the classroom. Teachers with ten or more years in the classroom were more likely to be behavioristically trained and had little knowledge of current science education reforms. Eccles (1993) affirmed that teachers need to understand adolescents, need to take charge of their own learning by creating a cycle of experience and need to use reflection such that continuous improvement is promoted in themselves (self-directed) and, ultimately, in their students. Improvement may start with teachers being agents of their own development (Policelli, 1987) by initiating activities that challenge, enhance, and question their own learning development and subsequent applications in the classroom.

The Problem

The foundation for this study is based on the uniqueness of the role of the middle-level science teacher

and his/her relationship with the growing need to understand teacher development during teaching, or the continued education of teachers. The investigation has focused on the interactions of teachers in the acts of planning and implementing instruction over two different units of instruction.

Uniqueness of Adolescents

Although professional organizations address the variability of the middle-level student, none speak to the greater depth of understanding needed by teachers of adolescents (Adams, 1998; Entwisle, 1990; Feldman & Elliot, 1990). Burman (1994) points out middle level teachers poorly understood adolescence. Adams (1998), in particular, claims that teacher understanding of adolescence is missing from the typical teacher preparation program. New teachers may not understand, for instance, that hitting a peer hard on the shoulder is a greeting and not a bully exercising control. Or, taking a notebook isn't stealing, but a sign of endearment, "I like you." As such, for the middle-level teacher, knowledge of adolescence is essentially an unknown and raises very important questions about the needs of teachers who have the task of educating this group. In light of these needs, teacher preparation programs do not ensure that potential middle-level teachers receive the preparation necessary to make their teaching experiences successful. Adams (1998) argues that current programs view adolescence as "Sameness" or place adolescent development into orderly steps

of maturity. Sameness makes it easy to group by age, one size fits all, which erases differences and promotes tracking (Fine & McPherson, 1992; Fordham, 1993; Lesko, 1996).

Potential employers of middle-level science teachers simply do not have the option of selecting teachers who are expressly educated to do so (Irvin, 1992). As a compromise, principals will hire teachers prepared for elementary education over those prepared for high school education. In a revealing survey (N=1500) of practicing middle-level teachers (high school trained), many participants admitted that they were in a holding pattern for a high school position (MacIver & Epstein, 1991). These findings suggest that many middle school teachers are not committed to the middle-level philosophy and students. More importantly, they were not likely to be disposed toward professional growth that would enhance their middle-level teaching skills.

Problems With Current Professional Development

The inability of middle-level science teachers to understand middle schools continues to be problematic because traditional in-service programs are inadequate (Goodlad, 1984; Senge, 1990). As Miller (1996) said, "The one-shot workshops are timeless models in a world where everything else has changed." The teachers find the instructional goals of workshops and in-services meaningless (Crump et al., 1988; Munby, 1984; Olson & Singer 1994) and trivialized (Apple, 1986; Giroux, 1988). Buchmann (1990) suggests teachers are part of the problem, with their entrenched thinking and crudeness that is marked by non-reflective thought. She suggests that students of these teachers would be taught undemanding and non-stimulating activities. Shor and Freire (1987) describe a trivialized curriculum as leading students into a "culture of silence," characterized by dull and unengaged learning.

Teacher Thinking and Reflection

Teachers struggle in their first years of teaching, doing what they can just to survive (Short, 1992), leaving little room to analyze their teaching experiences, make decisions or think through a problem. Dewey (1933) explained that the lack of these abilities leads to misguided practices. The unreflective classroom can deprofessionalize (McNeil, 1988) and deskill (Short, 1992) teachers, weakening their ability to respond to teaching experiences (Berliner, 1987) and initiate change (Nichols & Thorkildsen, 1995). Years of being told what to do breeds a dependence on other people's ideas and builds the sense that one's knowledge is unimportant.

Self-direction and Professional Development

In several reviewed studies, it was noted that a critical factor to teachers' productive thinking, reflecting, and change in actions and knowledge is tied to the quality of reflection on teaching and their own learning (Britzman, 1991; Schon, 1983). Hart, et al (1992) suggest that reflecting and thinking about classroom experiences are ways

for teachers to be aware of how they teach, but teachers are not naturally reflective (Britzman, 1991; Shulman, 1987). Britzman (1991) described how the absence of reflective abilities limit the type of teaching and learning decisions preservice and practicing teachers make, as well as prevents teacher learning. Wedman and Martin (1991) posit that purposeful reflection is critical to planning innovative lessons, interacting with adults, enhancing student achievement, designing good curricula, and understanding assessment. The isolated classroom will keep teachers away from the very elements that could free them (Crump et al, 1988; Johnston & Whiteneck, 1992; McKee, 1988; Straham, 1993). Lieberman (1995) sees teacher isolation as a powerful impediment to reform and feels that teachers need time to read, to learn, to talk about their learning, and to think through situations, which favor personal growth. Buchmann and Floden (1993) labeled this process as de-isolation, when professional development moves the teacher's role to communicator of teaching, learning, and promoting change.

There is limited research literature on the relationship between teachers' actions and teaching experiences. Johnson and Carlson (1992) found that nonreflective practitioners could not express their knowledge, beliefs or articulate what they knew. This suggests that non-reflective science teachers' teaching behaviors may not originate from past educational experiences or previously developed beliefs, but lie unimaginatively in a book, or status quo. Wilson (1994) described a teacher who knew she

should be trying to teach the workshop activities, but chose to stay with her traditional activities except on the days when Wilson observed her. The teacher reflected that Wilson's observations forced her to teach the workshop lessons, and after several observations and teaching the activities, she saw the activities going well. Then she entertained the idea of changing her teaching practices. Several researchers contend that teachers can construct knowledge as the result of classroom experiences (Barrow, 1991; Johnston and Whiteneck, 1992; Richardson, 1994; and Wilson, 1994). Nespor (1987) differentiated between knowledge and belief, arguing that knowledge is systematically stored while beliefs lie in episodic memory, a holding system for past events or experiences, suggesting that at this level, they are not deep. However, it takes several reoccurring events (experiences) with common components for episodic memories to become permanent memory (Thompson, et al, 1996). Thus, Wilson's teacher is in the act of replacing beliefs and continues as long as she can find worth in the new activities. Nespor (1987) suggested that belief or knowledge at this level is incidents of episodic memory connected to behaviors. Guskey (1994) concurs, suggesting that behaviors (experiences in action) precede the development of new knowledge and beliefs, which result after the effects of a new experience and change. Wilson's teacher found that after each experience teaching the new activities she was facing the challenges presented by facing up to self-reflection and analysis of teaching acts

(Stenhouse, 1975). Sockett (1985) states that professional judgment occurs when teachers apply experiences to improve practice. Dewey (1910/1933) called this "habits of reflection," containing intellectual attitudes of openmindedness, wholeheartedness, and responsibility. Burden (1990) summarize everything with the point that evolving knowledge includes changes in personal growth and professional development that take place during the processes of thought and practice.

The relationship of the personal development and the effects of experiences in the middle-level science classroom are questioned. Since development occurs within a social environment, questions are raised about the significance of classroom culture and climate. The social interactions in the science classroom may result in negative and positive constraints to teaching and learning and may or may not offer teachers opportunities for learning and the acquisition of new knowledge and, ultimately, development. Examples of negative constraints are noted in Schank and Abelson's (1977) and Abelson's (1979) concept of a "scripted" environment, which is an extreme allegiance to routines. The "scripted environment" could rob teachers of meaningful time, and goes unnoticed in an unreflective mind. The teacher who routinely shuffles roll sheets, calls names, tapes the student attendance list to the door and misplaces the tape, has carelessly lost several minutes of good teaching time per day. In weeks, the time lost will be hours. Surely now, the time lost is an impediment to learning. The unreflective

teacher, in this instance, would claim no time to be innovative or reflective, no time for thoughts on teaching and learning, no time for the selection of content, and no time for planning activities (Fine, 1994). According to Geertz (1973), this is a human nature component of culture and climate. Kennedy (1991) likens this situation to "noise" or climate, which makes actions seem less.

Ajzen and Fishbein's (1980) "theory of reasoned action" connects personal growth and the classroom culture. Personal growth refers to the evaluation of a behavior and one's perception of the social pressure to perform or not perform a particular behavior. The workplace affects development. Specific events or recurring episodes require teachers' interventions to override the "scripting" character (tendency to make routine) in order to be innovative in teaching and learning. The implication is that teacher empowerment becomes a guiding force to foster, develop and implement greater personal growth and professional development.

Science teacher education and teacher professional development reform, both reflects the lack of teacher "voice" (Cochran-Smith & Lytle, 1993), and this is particularly true for the middle-level science teacher. In this view, teacher voice is a perspective, a frame of reference, to what is inside the teacher's head. Teacher voice is about empowerment and experiences, which are also missing elements in the description of teacher growth and professional development. Cochran-Smith and Lytle (1993) feel the omission ignores the importance of teachers communicating

their wealth of knowledge to other teachers. Britzman (1987) writes that it is important to understand the process of teaching and learning from the perspective of teachers, which is "practical teaching" (Darling-Hammond & McLaughlin, 1995a) or teachers attempting to describe what they know and how they know it. They claim that it should be at the center of professional development efforts. The profitable utilization of teacher experiences is undercut and denounced if the validity of research is supported only by the educational authorities on research (Buchmann, 1990). Buchmann further argues that if only the authority of a single group of researchers is accepted, discussion is closed off.

The significance of teacher voice is that it is, perhaps, the reflective element in biographies, conversations, metaphors, stories, and reflective thinking. Connelly and Clandinin (1995) reported that this element is associated with teachers as narratives in action. Orenstein (1995) suggested that teachers writing about themselves and viewing themselves in narratives represent extensions of personal growth. As such, presenting an enhanced picture of what is inside a teacher's head could expose experiences and beliefs through voice, teacher talk. Empowered teachers, through reflective narratives, can describe in convincing ways what teachers do and think when teaching and learning.

It appears that teachers are beset by scripted behavior (Abelson, 1979), conformity (Britzman, 1991), survival (Adams & Krockover, 1997; Fessler & Christensen, 1992), and the status quo, all of which are constraints to teaching and

professional growth and development. To face these constraints, teachers may need to take an aggressive stance (be self-directed); for instance, they may need to follow Postman and Weingartner's (1969) proposal of subversive teaching, or pursue Freire's (1970) acts of freedom. As teachers become critically aware of themselves as potential meaning-makers, they may be both liberated and empowered. As a result, teachers may find themselves in a broader thinking and learning mode. Teachers may then be encouraged to be self-directed in their actions to transform teaching and learning and to satisfy their needs for personal growth and professional development.

Restatement of the Problem

Understanding and meeting the needs of the adolescent are here considered a mandate, both in purpose and direction, in order to look closely at middle-level science teachers' experiences. This suggests taking a close look at teachers' abilities, demonstration of thinking and reflection, and behaviors in the classroom to understand how actions and experiences interact and evolve to create new teaching experiences in teachers. Day to day classroom experiences form the basis for this study, and they provide the potential and opportunity to identify factors which impact teaching and learning and which relate to teachers' sense of personal and professional growth. This study invokes Dewey's (1916) point that denying teachers the ability to self-direct is sentencing them to following mechanical rules of teaching

without including a rich breadth of interests. This study will focus on the following questions:

- 1. How do middle-level science teachers plan and implement instruction?
- 2. What is the impact of "new" subject matter and/or a "new" instructional approach on middle-level science teachers' planning and implementation of instruction?

Significance of the Study

This study has the potential to provide information about middle-level science teaching and learning experiences that are presently absent in the science education literature. It suggests a need for better preparation for the preservice teacher, and its continuing needs for practitioners. They need to turn teaching experiences into greater understanding, knowledge of teaching and forms of meaningful and effective personal development. The study will provide information about how middle-level science teachers plan and implement instruction, their interaction with these experiences and what they actually do. This information is important for a number of reasons. It can be used in science methods courses and other professional development activities aimed precisely at the preparation of middle-level science teachers. The information could serve as a foundation for science educators to diagnose the needs of middle-level science programs and teachers. It will also offer a guide to support teachers and help select teacher development objectives that focus on long-term personal

growth. The greater understanding of teacher actions will shed light on developing courses and teaching. Further, the study of teachers' classroom experiences can help teacher educators understand the needs of teachers at different times in their careers. Lastly, this study may suggest ways for teachers to gain a sense of accomplishment and confidence in the pursuit of their own self-directed development.

This study is a part of a research agenda that includes but is not limited to addressing the nature of teacher selfdirected growth, extended experiences and university professional development programs for pre-service and practicing middle-level teachers. How should educators be involved with practitioners' professional development? How can programs assist practitioners in their quest for personal growth and professional development? Other aspects of this research agenda are the assessment of the effects of teacher growth on student learning and education and the extent to which teachers are able to sustain themselves as agents of their own development.

CHAPTER II

Review of the Research

Introduction

The purpose of this study is to explore the evolution of practicing middle-level science teachers' experiences in how they plan and implement "regular" and "new" instructional materials or approaches and what effects this may have on the teachers' personal growth and professional development. Following is an extensive search of the literature that informs the theoretical framework for this study.

This chapter is divided into three sections. Section one develops a relevant picture of science teachers' reflective abilities and skills and how these relate to personal growth and professional development. Section two examines teachers' experiences in the classroom. Section three explores how personal growth and professional development are impacted by teachers' experiences and how these experiences may interact with the teachers' perception(s) of events. This chapter also focuses on teachers' perceptions of their teaching, how they think they are teaching, what they think about when they teach, and how these perceptions might affect a change in their behaviors and actions. The final part of this chapter looks at how teachers' experiments in teaching and learning may impact their personal growth and professional development. The goal of this review and subsequent investigation is to develop

understanding of the constraints and barriers that may affect teachers' attempts at personal growth and professional development in teaching and learning.

Teachers' Reflective Abilities

The call to teach reflective thinking in science is not a new one. In 1910, Dewey claimed that the purpose of learning should be to create thinking men and women. Science is an act of inquiry leading to a "scientific attitude" or "intelligence." Dimnet (1928) elaborately expressed that the means to strengthen people's thinking capacities is to broaden the field and raise the level of their thoughts. This would, proportionately, increase their influence.

Reflective thinking needs is essential for schools and students to be able to operate in the 21st century. According to the Secretary's Commission on <u>Achieving</u> <u>Necessary Skills Report</u> (Author, 1995), critical thinking is a goal for every worker, and science teachers are in an excellent position to promote higher order thinking skills. The report asserts that teachers need to be reflective thinkers in order to develop a community of reflective thinkers (NRC, 1996).

Teachers' Critical Thinking Abilities

This section assesses studies focusing on the presence of thinking and reflection skills in teachers. Research involving teachers in such work may extend and improve understanding of teacher actions and thinking. Three critical thinking studies were authored by the same researcher and are briefly summarized. The purposes, methods, and results were nearly identical in the first two studies (Jungwirth, 1985, 1989). The participants in each study were preservice teachers, practicing teachers, and students (high school, college) in science from Austria, Israel, Italy, South Africa and United States. The Analysis of Scientific Passages Test was the main data source (Jungwirth, 1985). The test was found valid and reliable.

Jungwirth (1985, 1989) found that science teachers (95%) from these countries could not distinguish the relationship between a sample and a population, recognize what constituted evidence, recognize a variable or tell when the variable affected the situation, or draw a conclusion correctly from evidence 50 percent of the time. Jungwirth concluded that these science teachers would have difficulty teaching thinking in an activity-oriented science class. Jungwirth's (1990) added to these results with two more studies that concluded teacher thinking skills existed at three achievement levels: nonuser, latent, and spontaneous. Spontaneous and latent users have some thinking ability, but non-users do not. Spontaneous users would use a strategy such as controlling variables; whereas, latent users would use the strategy only after receiving prompts or aids to bring out the critical thinking. The results indicated that 37/76 teachers were at the nonuser level or without formal competence and 31/76 was at the latent level. Jungwirth argued that these science teachers' thinking skills were

unusable because their thinking skills could be accessed only through physical and mental prompts. The author noted that some teachers recognized the prompts and were able to relate the similarities to the previous set of questions, although they did not do so at the time of testing. Jungwirth pointed out that in real life, prompts like those on the test are not available, nor is it likely that schools would be able to develop the types of prompts needed by teachers to awaken latent thinking skills. In fact, he suggested that schools contain constraints that make it very difficult for these skills to be awakened. Consequently, teachers' thinking skills are not available. Jungwirth found teacher's (8) at the spontaneous level would use their thinking skills if they were disposed to act; however, Jungwirth found that these teachers did not teach thinking skills. As a result, he concluded that teachers lack a disposition for teaching thinking. Jungwirth also pointed out that school organization could be a culprit in teachers' non-use of critical thinking skills.

A part of Jungwirth's studies were aimed, as a response, at the Garnett and Tobin (1984) study. The Garnett and Tobin study suggests that a segment of the science teacher population is incapable of thinking. Jungwirth considers this to be too extreme. A better determination would have been that many teachers are unable to demonstrate their skills or are nonusers, which implies they could apply these skills if they received adequate instruction.

Holmes conducted a study replicating Jungwirth's studies (1996). He found results for practicing middle-level teachers (N= 27) and a preservice cohort of K-8 teachers (N= 37) to be very similar to those obtained by Jungwirth. Nearly half (36/64) were in the 50th percentile or less (36/64), and 23/64 were in the latent group. Five teachers' scores placed them in the high or spontaneous level (5/64).

The main point for reporting the Holmes study is that teachers in the spontaneous level (possess critical thinking skills) were noted to have had a research background. Interviews revealed that these practicing teachers were more active and innovative in their thinking and teaching behavior and sought schools where the culture and climate allowed them to be innovative and carry out their curricular plans.

A study by Garnett and Tobin (1984) had a dual purpose. One purpose was to determine the formal reasoning levels of preservice science undergraduates. The second purpose was to compare high school science backgrounds. They posited that a student with a specific biological or physical science background would be a better critical thinker than one with a non-science discipline background. The authors saw connections between ways of thinking and science content. Proportional reasoning was connected to the quantitative nature of science and correlational reasoning to identification and verification of relationships between variables. Combinatorial reasoning was identifying patterns in science. In the Garnett and Tobin's study, the idea of limited reasoning patterns referred to the manner in which the teachers responded to each question. A test question was scored correct or incorrect. A survey question could be marked incorrect. It is possible that the same incorrect responses could occur. This was counted as a limited response pattern and measured in percent. For example, Proportion item #1 received the incorrect answer 10X (23%). The teachers added the ratio rather than multiplied, "How much juice can be made from six oranges?" Garnett and Tobin determined that proportional thinking achieved the lowest scores (50th %). As a result, they concluded that the lack of thinking skills significantly curtailed teacher effectiveness to teach thinking-oriented science lessons.

White and Burke (1992, 1994) assessed the thinking abilities, feelings and attitudes about teaching in middle level preservice teachers at a Texas university. Each participant in the subgroup completed the Watson-Glaser Critical Thinking Appraisal test (WGCTA, 1980) and the Survey of Teacher Attitude Test (STA, White & Burke 1992).

The STA was offered as evidence that teachers held a strong consensus in five areas of education reform. The areas were (1) classroom evaluations systems, (2) teaching and learning, (3) beyond the essential elements of teaching, (4) salary and rewards for teaching, and (5) motivation of teachers and students.

The authors separate the results, discussions, conclusions and implications into two parts. The teacher

thinking (N=32) scores range from a low of four to a high of 16, a range that is large and bi-modal. The authors attributed the distribution to the school's program admission policy of easy in, easy out; however, further inspection indicates that these scores are comparable to the general college population. The mean critical thinking scores are reported for each of the subscales. A brief discussion follows, noting the subscale score and a comparison to the college student national norm. The six subtests are inference, recognition of assumptions, interpretations, deductions, evaluation of arguments, and total critical thinking. The inference subscale measured each individual's ability to draw a conclusion from observed or supposed facts, and to use the concept of probability in the thinking process. In the thinking process, one moves away from certainty and estimates truth or falsity by judging the probability of the situation. The inference scores were low (M = 9.2) compared to the college norm of M = 11.8. The authors suggested that some teachers with low scores would have a problem drawing inferences.

The recognition of assumptions and interpretation of argument M =12.5 and 12.6 were above the college student average of 11.8. These scores suggested that teachers would be able to recognize reasonable assumptions and use cognitive functions to judge whether various proposed conditions followed logically from a given set of information. However, the authors believed that there are some teachers who would really struggle in this area. The subscale deductions and

evaluation shared slightly lower results M = 11.3 than the college norm of 11.8. These results suggested that some teachers would have difficulty making reasonable conclusions.

White and Burke noted that subscale scores were not particularly high, being in the 50th percentile or lower, and slightly below the college student norm. The authors found that one-half of the teachers had low scores, which suggested these teachers would have a difficult time teaching critical thinking. White and Burke argued that teacher education programs need to be examined for thinking activities, and that such activities should be added when absent.

Analyses of the STA were reported by using the factor analysis by principal component method. At least five major constructs or presumptions about issues in the education reform movement were noted. There was significant item loading of (.40) in the factor structure of the survey. In factor one, teachers agreed that there are a variety of ways to measure teacher performance if the instruments used are valid and reliable instruments. Teachers, however, were concerned that the instruments would be used in a formative and not a summative way. In factor two, teaching and learning, teachers suggested that (1) students must learn how to learn, and (2) an effective teacher must have high expectations, (M = 3.7). In factor three, teachers rated different and effective ways of teaching, suggesting that teachers should try to engage the cognitive process of the learner by urging each student to work toward his or her highest potential (M = 3.8). In factors four and five, the

teachers voiced concern about what characteristics were developed outside of school and the expectation of student performance. These teachers felt they could reach every student, given enough time. White and Burke suggested that the test results indicated teachers' readiness to work with students by making students more aware of useful programs and by encouraging their hope and caring.

In their second study, White and Burke (1994) were concerned with the nature of preservice teachers' critical thinking skill levels and personalities. The authors found in the literature that successful elementary teachers were enthusiastic, warm, hopeful and social. They argued that possession of these characteristics would be a good predictor of successful teachers. The participants were asked to respond to the Myers-Briggs Type Indicator (MBTI), which was used to determine personality traits. The WGCTA test was used to measure critical thinking, and a third instrument, "My Personal Beliefs," was used to measure the locus of control (Rotter). The locus of control test was used on the assumption that it would predict the participant's performance on the Texas Teacher Certification for Licensure Test (TTCL), which is a criterion reference test used to test all grade levels and content areas. The Teacher Performance Appraisal Instrument (TPAI, North Carolina Department of Education, 1986) was used to predict thinking abilities. This data was not used in the data analysis. Teachers were also asked to comment about the three best things from their program experiences. In response, most commented on

teaching, the cooperating teacher, and the opportunity to be on their own.

Results and data analysis were completed on each test, then discussed by combining results. Teachers were found to be more introvert (M= 19) than extrovert (M= 10) (MBTI). White and Burke concluded that teachers would think before responding, focus on internal thoughts and ideas, seek opportunities to communicate one-to-one, and be reflective. The authors argued that these conclusions were generated by the Rotter's and MBTI test scores; however, the MBTI does not measure thinking and reflection. Only the WGCTA can measure thinking and it was not used for this purpose. The other tests did not measure reflection, nor did the teacher education program emphasize reflective teaching.

In the final analysis, the authors found low critical thinking abilities for the soon-to-be-certified teachers. Attempts were made to correlate critical thinking with personality, but no relationships were found. Overall, relationships between critical thinking and the personality tests were inconclusive.

A study by Cass and Evans (1992) was designed to examine the critical thinking skills of practicing special education teachers. The authors suggested that special education teachers be regularly called upon to use and teach critical thinking. They must use thinking skills as they plan, analyze, synthesize and evaluate behavior, plan remedial goals, anticipate learning problems for students, and work with exceptional children. The research involved a

contingent of special education teachers (N= 117) attending a summer program at a southern university. The group consisted of 94 females and 23 males. The average teaching experience was five years and included elementary, middle and general special education teachers.

The results indicate that few teachers are capable critical thinkers. The range of scores is wide, with few teachers above the 50th percentile. The total mean score of 55.9 places this group well below the 50th percentile, which is much lower than scores previously reported in the research of White and Burke (1992, 1994), who used the same test. Again, particularly low scores were recorded for the inference subscale. According to the authors, these teachers had a weak understanding on how to draw conclusions based on observations and evidence, and had a poor idea of probability and proportional thinking. These results are similar to those reported by Garnett and Tobin.

Cass and Evans concluded that one-half of the teachers had proficient thinking skills but did not display them, suggesting that even though the skills were present, teachers did not make them available in their teaching.

Crump, Schlichter, and Palk (1988) reported on a twoyear study involving Vestavia Hills School District in Alabama. The study's purpose was to describe a personal and professional development program addressing students' and teachers' critical thinking skills. Several questions were asked: What will be the attitude of middle and high school teachers toward workshops involving higher-order thinking skills (HOTS)? Will middle school teachers differ in their self-appraisals of HOTS? Will teachers judge different thinking skills more difficult to teach than others? Will middle and high school teachers differ in how they teach HOTS? Does the performance of students improve with increased teaching of critical thinking skills?

Talent Unlimited, a university in-service model was used to assist teachers (N= 87) in teaching thinking skills. The model consists of six areas: (1) productive thinking -to generate many varied, unusual and detailed ideas and solutions; (2) decision--to make final judgements; (3) planning--to design and carry out ideas; (4) forecasting -to make a variety of predictions about cause and effect; (5) communication -- to use and interpret both verbal and nonverbal forms; and (6) academic -- to develop a base of knowledge and/or skill about a topic or issue.

The participants received 18 hours of direct instruction on using the nineteen thinking skills, followed by a spring workshop that consisted of sessions on content and teaching methods. In the second year, 12 hours of training and six hours of technical assistance were delivered to small group and individual conferences. All teachers received assistance in writing lesson plans to incorporate the 19 skills. The lesson plans were collected and shared. Teachers documented their use of thinking skills in a daily journal and used them in follow-up small group discussions. The trainers also kept an anecdotal record of meetings and conferences.

Students were selected from a random sample of sixtheighth grade students (N=42) and ninth-eleventh high school students (N=42) which was five percent of the combined school population. Student achievement was measured by a pre- and post-test (Criterion Test, 1974), at the beginning of the first year and in April of the second year.

Teachers evaluated the in-service training using a five-point Likert scale instrument. They rated the workshop objectives, relationship of workshop content to their classrooms, and the perceived value of the Talents model. In the second year, ratings of the program used the same instrument with added questions to rate their understanding of the talent skills. Throughout the two-year period, teachers rated their actual use of the Talent materials and recorded the ratings in their journals.

Middle and high school teachers also rated their understanding and preparedness to teach the thinking skills. The percentages were calculated and compared, using the chisquare goodness-of-fit test. Two ratings were developed for 1) the initial workshop and 2) implementation phase thinking skills.

The workshops received the highest ratings from the middle and high school teachers; however, researchers noted that the ratings decreased for implementation phase, but the authors did not speculate on why the ratings were lower. It was found that middle (14%) and high school teachers (25%) rated the workshop's relevance to the classroom low. It appears that the teachers were less satisfied with the

implementation phase, especially the high school teachers, who did not find the materials relevant to teaching.

The results of teachers' knowledge and preparation to teach thinking skills had significant differences (P<.05) among high school teachers' (14%) and middle school teachers (42%) on the preparation to teach decision-making. The authors suggested that the high school teachers encountered difficulty in integrating the thinking skills with the disciplines they taught.

Middle (72%) and high school (56%) ratings on implementation strategies and attitudes on thinking skills instruction were significantly different. The related category, teaching thinking skills, had the middle-level teachers at 88% compared to the high school teachers at 75%. There were no significant differences between groups (p < .01). The frequency to teach thinking skills was significantly different between the middle (54%) and high school (32%) teachers. The teachers' journals supplied the actual times when teachers taught the thinking-skill activities. The area consisted of flexibility and originality. The thinking skills were taught more often than any other skill. Eight Middle school English teachers reported teaching 49 activities compared to the nine high schools English teachers, who taught 68. In science, five middle school teachers reported 20 activities and one high school teacher reported one activity.

The last analysis compared student-thinking skills. On pre- and post-tests, the middle school students did better
overall than did the high school students, particularly on communication and planning skill areas.

The authors' conclusions minimize any interpretive comments, reporting only values and descriptions. They conclude that the Talent Unlimited Program is successful in enhancing the understanding, thinking skills and attitudes in teachers.

The McKee (1988) study presents findings based on a three-year study involving the collaboration between university and school district personnel. The project's purpose was to prompt greater critical thinking skills in social studies classes. The research purpose was to see how teachers understood and implemented innovative approaches in instruction and to provide insights in the change process.

Seven 11th grade history teachers at three high schools in a northeastern industrial city were the participants. They averaged 10 years of teaching experience and appeared to be dedicated, professional, and articulate. They volunteered for the project and expressed positive attitudes toward it. The author said, the project differs from previous curriculum innovations, because of the (1) emphasis on students' critical thinking skills, (2) materials that are nonprescriptive (guidelines and sample lessons), and (3) development of activities by teachers not in the study but under the direction of the director of the study.

The study's data consists of an ethnographic analysis of the teachers' concepts of critical thinking and teaching, and the project's concepts of workshops--materials and

activities. Other data sources were classroom observations, transcripts of structured teacher interviews and informal conversations, school documents and notes on in-service and advisory committee meetings. A trained university team of observers collected the observation data. The interobserver agreement was 80% and was checked for coding drift by the project coordinator. None was found. The project defined critical thinking as active inquiry rather than the passive accumulation of knowledge; the assumption was to think critically and to question definitions, actions, and beliefs.

Data analysis utilized a three-step interactive process recommended by Miles and Huberman (1994). The three steps are (1) data reduction in which raw data were paraphrased and summarized, (2) data display in which information is organized into graphs, networks, and matrices, and (3) inference and verification in which regularities, patterns, explanations and themes were noted and causal flows were checked for plausibility.

The first analysis developed a profile of teachers' concepts of critical thinking and teaching critical thinking. Comparing teachers' concepts of critical thinking to the project's critical thinking materials followed. McKee found a discrepancy between teachers' concepts of thinking and teaching thinking, to those of the project. Teachers conceived critical thinking as separate skills (e.g. comprehension, summary) isolated from the course content. The project authors see critical thinking as raising and

pursuing questions about one's ideas and expressing them through essay writing.

The project's second emphasis was to involve teachers in more questioning and students in more discussion, but no evidence was found that teachers increased their questioning, using fewer than 1.6 questions per class, despite using project materials 89% of the time. Teachers used 70% of the class time to present lessons. Only 4% of the time did any activities require some reasoning. The usual questions asked by teachers were procedural and required no thinking. In follow-up interviews, teachers claimed they were "instructing for critical thinking." The author, however, found that teachers' lessons were very mechanistic and fragmented.

McKee looked at institutional conditions for some answers as to why teachers did not implement new programs as She posits that teachers realize they always have intended. been operating within a well-established norm. They like what they are doing, so why change? The act of implementing a new program is often disruptive and runs contrary to the It would require change, which would confront teacher norm. ideologies and interpersonal relations. The author contends that teachers react by filtering the critical thinking concepts out of the program. Teachers use their ideational systems to modify concepts to reduce ambiguity and risk to conform to pre-existing practice beliefs, especially those pertaining to teacher efficacy and authority. One interviewed teacher said, "My goal is to get through the day with as few hassles as possible." These words inferred that

the project's lessons were "too much of a hassle" and a threat to the teacher. The program's views and teachers' views of students' learning were different. Teachers reported that most of their students were unable (e.g. poor reading skills) or unwilling (apathy) to meet the demands of critical thinking. One teacher believed students were only concerned about McDonald's, music and watching MTV and nothing else existed for them. In contrast, the program model assumed that all students could and should be taught critical thinking skills and that teachers could have related critical thinking to the characteristics of students; however, the teachers reduced the program goals as if no differences existed. Teachers were observed to negotiate with students to simplify the program's activities by defining critical thinking as separate skills, and would adjust individual tasks to things most students could do.

McKee argued that teachers altered project goals because they desired a high degree of control over student learning. Teachers often speak of keeping students on track and fear losing control of the class. Because of this, teachers resort to asking short or one-word-answer questions, which allows them to maintain control in a business-like manner. The program, on the other hand, expects greater discourse and a more personal interaction with students.

In concluding statements, McKee suggested that teachers have two ways of dealing with knowledge as it affects their teaching. The first is the public or consensus view, or what is seen in the classroom, where using textbooks and teaching

facts as knowledge are the main products. The author found that the school district contributed to teachers' strategies by requiring standardized testing, which contradicted administrators who said they were in favor of critical thinking activities. The second view held by teachers is the private view, or that of being able to distinguish among real life issues. That is, teachers are quite capable of dealing with life issues outside of school. While the program asked teachers to model critical thinking, they did not. It appears there were no incentives for teachers to model critical thinking. They covered only the material for the day and moved on. Consequently, McKee suggested that that these teachers were subject-matter specialists and content knowledge dependent. Students, from this perspective, cannot participate in discussion because they don't know enough or cannot read well enough to know anything; thus, the emphasis is on learning facts. This leaves little time for the development of higher order cognitive thought. In summary, teachers modified, rejected and adapted the program to reduce ambiguity and risk. This insured teacher authority and reduced the chance of being judged incompetent by administrators. Therefore, the teachers elected to teach the memorization of facts and teach to the test.

McKee also suggested that two other interpretations of the data were possible. The first was that teachers have seen many innovations come and go and they have developed coping strategies that ride the tides of change and return to normal. The second is that teachers, indeed, lack the skills to interpret and instruct for critical thinking.

The implications of this study, according to the author, suggest that the role of the teacher and implementation of curriculum are affected by school conditions that inhibit or encourage change and professional development. When programs are in conflict with teacher ideologies, it is unlikely that sweeping changes can be made. Also, teachers are also not likely to evaluate their own theories that could impede change. In this light, McKee raises the concern that a lack of teacher reflection keeps teachers from moving toward a greater awareness of their teaching. She quoted an analogy to illustrate this point. A farmer declines booklets from the county agent on how to farm better, explaining, "I ain't farming half as good as I know how to now." It may be that veteran teachers are suffering from a similar lethargy or failure, or that inability to be reflective may be why some teachers do not teach as well as they know how.

Britzman's (1991) study follows a student teacher, Jack, through his field experience as he tries to reflect and think his way through field placement, school, interaction with peers and mentor teachers, and teach a critical thinking unit to a 9th grade history class. The study is an ethnographic case study of one. The author extensively explains her perceptions about Jack, mentors, school, students, teachers, and community.

Data, data analysis, results, and conclusions are found interwoven and written into a narrative, telling the story of the student teacher's "lived experiences." The story unfolds, describing both Jack's past and the university experiences that have meaning to him in his field position. Jack's "baggage" is noted, labeling his intentions toward teaching, learning, and what he considers his choices for personal growth and professional development.

A series of six two-hour interviews were conducted before, during, and after the observations of the entire student teaching experience. Interviews with school administrators, Jack's mentor teacher, students, and noncertified personnel made up the data set. In addition, Jack's classroom papers, examples of student work, and the school's daily parade of papers were collected and analyzed.

Britzman found that Jack was not naturally reflective. She explained that Jack found himself in a situation that made it easier for him to join the ranks of a disenchanted staff and play follow-the-leader rather than be reflective and act accordingly. Further, she recalled Jack mentioning in an interview that his choice to join the group, even though they professed attitudes, which he wanted to avoid, was considered easier since he considered student teaching not to be real teaching. Jack's second mentor teacher could have provided an opportunity for Jack to teach according to his intentions. She worked outside the circle Jack joined and voiced beliefs, attitudes and behaviors for teaching and learning similar to those Jack said he agreed with.

The author concluded that Jack could not confront the influences of a negative mentor. Jack's classroom behavior provided a further example of his choice to ignore student behavior problems, explaining he did not want to stifle their spontaneity, which went uncontrolled. By ignoring the class behavior, Jack had nothing to reflect about, nor could he question how the students might view his selection of activities. Britzman suggests Jack's limitation is his unreflective acceptance that how he learns is the best teaching approach. He learns this way, so it must be good for his students to learn the same way. This results in the design of critical thinking activities well above the abilities, knowledge, and experience of his students. The author concludes that Jack's own student experience formed his teaching intentions and practice.

Jack, responding to interview questions, mentioned that he did notice some inconsistencies in his first mentor's teaching methods. His first mentor taught from a textbook and emphasized memorization. Jack wanted to move the students out of the textbook and memorization by having them voice their concerns and understandings, but Jack was never observed to ask students to explain themselves, to elaborate on their views, or to interpret the consequences of the views they held. Britzman concluded that Jack's lack of reflectiveness was linked to his lack of content knowledge and inattention in pedagogy classes. Overall, Jack believed his field experience was not real teaching, and it was assumed that this would occur when he had his own classroom.

"In my classroom," he said, "I'm going to have to develop my own curriculum, or what to teach." (p. 166)

Britzman declares that Jack's intentions informed his teaching. His appreciation for critical thinking did not help him teach it. His only critical thinking experience had occurred in one history course in the educational program. Modeling his critical thinking lessons after his learning experiences was inappropriate, as his students' capabilities were not equal to his own. In an interview, Jack said that his field experience had not been real teaching and that he would forget about the outcomes until he had more teaching experience. The author believed that Jack could not rise above the constraining nature of his disenchanted mentor teacher, his inability to manage his classroom, and his weak history content knowledge.

Britzman concluded that Jack rationalized his way through his entire field experience, going so far as to call it a good one, even though he was frustrated by students' unwillingness to do as he asked. The author believed that Jack must have forgotten that she had been an observer in his classroom on many occasions and had observed the teaching experiences which Jack called well, but which she interpreted as poor teaching and weak classroom management. Jack, however, excused himself, when he gave in and adopted his first mentor's teaching strategies and followed the routine of weekly quizzes. Jack avoided his second mentor, the one person who taught the way Jack said he wanted to teach. Jack also excused his critical thinking lessons, saying they only

needed polishing. The author suggested that Jack overestimated his skill levels and was not prepared to teach critical thinking.

Jack's story is described in Britzman's interpretation of Jack's words, actions and behaviors. It is a combination of stories of other teachers, administrators and students. This becomes the context and culture for Jack's teaching and learning experiences. Interviews with Jack's mentor teachers and observations of their classrooms indicate the nature of Jack's learning experiences in those classrooms. Discussions and interviews with Jack present the complex nature of teacher and school, and suggested conflicted beliefs about teaching and the constraining nature of the lack of reflective and critical thinking. In Jack's experiences, personal development is on hold. The study opens to view a teacher who is not naturally reflective and who thinks about learning half-heartedly, believing that learning to teach is simply, "Practice makes Practice."

Wedman and Martin (1991) subscribed to Dewey's idea that reflective action leads to innovative, reflective and competent teachers. From this framework, they raised questions concerning preservice teachers' adjustments to learning critical and reflective skills. Their concern was whether or not preservice teachers with undeveloped reflective skills are able to critically analyze their teaching practices in an educational, social and political context. Would reflection influence less-than-favorable attitudes toward students, schools, and teaching? Would the lack of reflective activities inhibit their development for innovation, reflection, and competency?

In the Wedman and Martin study, there were 24 elementary and secondary teacher participants from a Midwestern University teacher program, with 16 females and eight males. Their teaching areas were Science, English and Social Studies. They were assigned to one of two field sites where a reflective model was in place. Each site had twelve teachers and one university supervisor.

A reflective teacher is a person who questions, analyzes, evaluates and reconsiders school practices in relation to self, students, curriculum, school, society and environment. A reflective teacher is one who questions, analyzes and evaluates. In contrast, a non-reflective teacher, or a routine teacher, is someone who accepts practices of the school and does not become involved in finding the most effective ways to teach.

Teachers were pre- and post-tested using the Posner Teacher Belief Inventory, which is thought to be a strong reflective belief indicator. The test measures assumptions about teaching: control, diversity, learning, teacher's role, school, society and knowledge. Three raters who identify reflective and routine characteristics in statements made by teachers established content validity. Interrater agreement is 95%, and test and retest reliability is .73. Three other tests, designed by the authors, were taken by the participants: Philosophical Orientation (PO), Problem Solving (PS) and Perception (P). The tests were used based on the idea that reflectivity can be indicated by beliefs, attitudes, thought patterns, viewpoints and problem-solving strategies. Experts who examined the questions for clarity and appropriateness determined content validity. Neither test examples nor values were given, but a sense of the task items is understood through the authors' discussion. The (PO) and (PS) instruments were used as pre- and post tests. The (P) instrument was used only at the end of the student teacher's field experience. No reliability or validity was reported for these instruments. Teachers maintained journals for the nine-week student field experiences. Teachers met in weekly seminars where journals, action research and other reflective practices were discussed. Reading assignments were required and teachers wrote in their journals.

Wedman and Martin found that the results of the Teacher Belief Inventory were mixed, with mean scores greatest for control, school and society categories, but not significantly different for pre- and post-testing (p > .05). Teachers' reflection scores decreased for diversity and knowledge categories (p > .05). On the (PO) instrument, teachers identified routine or reflective thought units by the frequency of occurrences. For example, a routine thought unit was, "The learner follows examples, lessons, and listens," while a reflective thought unit was, "The most important question is, What do we want to leave the students when we are done with them." (p. 37) Analysis of teacher context variables resulted in thought unit themes, such as referring to teachers' responsibilities to learners and roles as nurturers and classroom managers. An example of a routine unit was, "Teachers should be role models, always showing themselves as good human examples." An example of a reflective unit was, "I'm concerned that teachers have well established and defensible belief systems" (p. 37). The interrater agreement for grouping routine and reflective was 95%. A chi-square test was calculated between the pre- and post-test and the results indicated teachers use more routine thought units than reflective ones. Reflective thought units were identified for each context variable and found to increase from pre- to post-test. A chi-square test showed significance at p = .001, teacher variable X2 (1) 12.01, the learner variable X2 (1) = 27.68, and total thought units X2 (1)= 18.35.

The teachers' problem solving strategies were 100% routine. Over time, student teachers became less flexible for curriculum modifications and teaching methods, less willing to adjust for low achieving learners, more dependent on administrators and specialists to intervene on student behavior problems, and not willing to use instructional strategies to correct student behavior.

The analysis of the perception (P) instrument indicated that 18/23 students perceived conferences as contributing most to their personal growth in reflectivity, saying they were able to understand the complexity of teaching. There was no clear second choice among the other methods--seminar, journal writing, and action research; however, journal writing and action research did allow teachers to evaluate and improve teaching practices independently, to explore educational issues, and to examine relationships between school and society.

Wedman and Martin suggest student teachers focus on the how of teaching strategies and not the why of teaching practices (reflective). In other words, they operated at Van Manen's (1988) lowest level of technical reflectiveness. Teacher's struggle with the realities of the classroom and this overrides any desire to explore teaching practices through reflection. There is, under these conditions, little time to engage in reflective practice (Calderhead, 1989).

Wedman and Martin concluded that conferences lead to the greatest development of reflection when they occurred right after the teaching and where teachers were provided personal feedback. The focus questions raised issues that teachers had to think through and could not ignore. Journals and action research also received high marks for reflection development, but not in the context of student teaching and seminars, since they competed for time outside of school. The authors suggest that student teachers need instruction in reflective teaching behavior because reflective thoughts are liberating as opposed to the inhibiting nature of routine actions.

Wedman and Martin's final point is that the length of the field experience is too short to fully develop reflectiveness. They argue that reflection should be emphasized throughout the entire curriculum in a teacher education program.

A study by Strahan (1993) extends the concept of the reflection-based education program by looking at preservice middle-level math teachers and how they express reflection, work with their students, and how they think about the processes of teaching. The purpose of this study was to establish a series of case studies that documented how teacher reflection develops over time. Reflection is operationally defined as, "What a teacher does when he or she looks back at the teaching and learning" (Shulman, 1987, p. 19). The analysis of reflection used Van Manen's levels of reflectivity: technical, practical, and critical.

Four preservice middle-level math teachers were participants. All were female, three were white and one was an African American in her early twenties. The primary research period was the fifteen-week field experience. Each teacher had a doctoral student supervisor who was taking a seminar class on qualitative research methods. The interns' reflective journals and interviews were the main forms of data. The interviews were open-ended with questions such as, "Please tell me more about this," and "How would you describe what was happening?" Analysis of data was conducted by using Analyzing Reflections on Instruction (Strahan, 1993).

The data was turned into inferences regarding the teachers' orientations toward teaching and the evolution of these orientations. Once the orientations were identified, they were organized into themes that connected the teachers' perceptions of themselves, students and teaching, and then cross-compared. Three developmental patterns were identified

and integrated into themes for each case: confirmation of self as a teacher, differentiated perceptions of students, and developmental conceptualizations of teaching. Their statements about themselves formed patterns. For instance, Carol spoke about teacher duties, grades and meetings, "They really work hard: strong and good teachers who are sensitive to the needs of at-risk student are the very teachers we need." In these words, the interns are not the teachers they were talking about. The interns' journal entry reflections were in second and third person, and never in first person. Each intern's reflection expressed abstract and academic orientations toward teaching, students and planning. Strahan believes that the interns' comments stemmed from textbooks and academic orientations toward teaching, which meant the interns, perceived themselves as students.

Strahan found that interns, in the first weeks of teaching, were very busy at instructional planning and identifying how mathematical content is related to instruction. The interns mentioned that they never saw their mentors planning. It just seemed to happen.

The title "teacher," is a transformation that occurs when interns see themselves moving from student to teacher, however, powerful confirmation is necessary. The interns seek self-confirmation, affirmation through relationships with students, and validation for their success in teaching through student progress. Carol's journal revealed this pattern: "Only a few weeks have gone by, and I already feel like I belong. I have a relationship with my teachers that

is more professional. It's like a friendship, Mrs. P. told me; I'm part of the faculty" (p. 46). Each intern expressed similar thoughts, and by the end of the first month, they were describing their teaching in the first person and expressing more confidence in their performance. Ellie wrote in her journal, "I can see myself as a person that has everyone's respect, everyone's attention, when I'm assertive. Now, I can go in there with so much motivation that they hear it in my talk. They see my enthusiasm" (p. 47).

These statements involved validation of teacher success through student progress. The author argued that this was vague in the interns' journals and interviews, which were focused on activities. The supervisors found lessons followed the textbook and were closely scripted. The interns were frustrated when they had to match math concepts to appropriate lesson strategies. Ellie noted her frustration, "Although I had already written out a lesson plan, I was not properly prepared to teach it I don't understand or I'm confused. At the end of the period, I had an extremely negative attitude toward myself as a teacher" (p. 49).

Strahan suggests that during student teaching, the intern's focus shifts from rigid to flexible thinking and they see themselves as responsive individuals. The interns made repeated references to successful test scores, which validated their criteria for student learning. Strahan concluded that the interns evolve from student to teacher and transform from "Technical" reflective concerns to "Practical" dimensions, thinking through classroom dilemmas, modifying

plans, and meeting the individual needs of the students. Thus, interns' reflective skills evolve slowly.

Overall the reviewed papers revealed a common finding that teachers are weak in thinking and reflective skills, with well over 50% of those tested unable to demonstrate the possession of thinking skills. These results were based on some form of testing and only a few studies disclosed a data source that included classroom observations. The reflective studies confirmed the requirement for observation. Strahan (1993) found that reflectiveness was able to evolve as the result of different types of activities: conferencing, journal writing and action research.

It is no accident that thinking and reflective skill instruction is absent in many classrooms, particularly when many teachers do not possess the thinking skills they are to teach. It is this lack of reflective thinking skills that bears strongly upon how teachers function within the environment of their experiences. That is, how meaningful is the teachers' work as they plan and teach, and how do these experiences interact in their learning or development?

The teacher inability to think critically and reflectively are closed doors to meaningful personal and professional development. What is not very clear is why classrooms taught by teachers with reflective thinking skills are devoid of reflective teaching and learning. Jungwirth (1989, 1990) suggests that there is a potential for teacher thinking skills to be asleep, or rendered latent, in the absence of sufficient prompts to awaken them. Schools do not provide these prompts and actually create impediments, barriers to their creation (McKee, 1988). This follows Lederman and Zeidler's (1987) observations that teachers who possessed an understanding of the nature of science did not teach the nature of science in their classrooms. This introduces teacher choice and context as factors in thinking.

We see in the Crump et al (1988) study that high school teachers did not participate in a professional development Seemingly, high school teachers, in contrast to program. some middle-level teachers, are less receptive to reflective thinking or are unwilling to move out of their unreflective modes. As a result, teachers become less skilled, or deskilled (Kraft, 1996; Short, 1992), or deprofessionalized (McNeil, 1988). This suggests that teachers may have chosen to ignore or keep their skills in limbo and find it easier to leave teaching to textbooks, and that they are not motivated to be innovative. McKee's (1988) study verified deprofessionalization by illustrating teachers' domestication of a teacher education, thinking program, which tames a program down such that it bears little relationship to the original. Teachers' actions are both constrained and deskilled over a period of time. Crump et al. found science teachers tamed a program by resisting the program's activities. The teachers convinced themselves that the project activities were not relevant to their science classes and were not used. Cass and Evans (1992), Crump et al. and McKee (1988) noted constraining factors affecting teachers' abilities besides their lack of skills. McKee (1988)

addressed teachers' inability to teach what they claim they believe, which suggests that other factors can operate on teachers' abilities to change.

White and Burke's studies (1992, 1994) demonstrated that thinking skill education is not a part of pre-service teacher education programs. Newly certified teachers leave their programs without sufficient thinking skills. Crump et al (1988) demonstrated that teacher education programs, through staff development, could potentially be distributed to districts, but not without constraints, barriers, and teacher resistance.

Crump et al (1988) and McKee (1988) indicated that long-term inservice programs could improve thinking skills, but not without conflicting behaviors. Teachers refused to accept change while maintaining the status quo and routines. These behaviors are similar to those identified by Abelson (1979) as "Scripted." Teachers depend on rigorous routines. White and Burke (1992, 1994) found teachers leaving their education programs for their first teaching positions without adequate reflective skills (Britzman, 1991; Wedman & Martin, 1991; Strahan, 1993). Britzman (1991) and Jungwirth (1990) indicated those teachers' thinking skills do not improve with more teaching. Crump et al. and McKee (1988) suggest one reason is that unsuccessful projects are not learning experiences, thus not a part of the deliberations for professional development. In this case, teachers disclose distaste for the administrative management tools that leave them out of the decisions made for their professional

development. These studies revealed constraints, barriers, and impediments that inhibit teachers from attaining thinking and reflective skills and from experiencing meaningful personal growth or professional development.

The contradictions that exist in teachers' reflective thinking suggest a closer look at middle-level science teachers. The weak formation of reflection skills, not using thinking skills when available and the workplace suggest the need to examine teachers from the outset. The emphasis should be on the holistic dynamics of the personal characteristics of science teachers and classroom variables.

Teacher Behaviors

Research has produced a significant amount of information concerning teachers' thought processes (reviews by Clark & Peterson, 1986; Shavelson & Stern, 1981) on ways teachers think and what they think about in the acts of teaching. The previous section found teachers' reflective skills to be scarce, that teachers may not think very deeply, rely on routines or think on their feet. Schon (1983) provides further insights into the levels and complexity of teaching by proposing the notion that thinking-in-action is a reaction to the experience of teaching and may affect or modify what a teacher does in the heat of teaching. It is suggested that the teacher is learning while teaching and the experience benefits their development.

Another explanation for influence on teachers' experiences is found in ideas by Abelson (1979), who

suggested that critical episodes color or frame how a teacher will later comprehend particular situations in teaching and learning. This suggests that a particular incident from memory may be the basis for a particular way of teaching. For instance, a teacher may remember being read to as a good experience and later incorporate reading to his/her students: however, it does not mean that no reading in the background doesn't mean no reading in the present. It is possible, that the influence of past school experiences (Lortie, 1975), going to school K-16, may be less important than originally Teachers reactions to new teaching experiences have thought. just as much chance to be created by an incident today as it might have been created many years ago. This point suggests that teachers may filter experiences by context (i.e. science). Hence, teachers' experiences in learning to teach come from a variety of sources, which include new and old experiences and serve as accommodation tools to solve practical problems of teaching and learning.

Teachers in the classroom act out or exhibit behaviors that have result-based implications when students and student achievement influence or guide practice. Teachers also may be developing a new set of learning tools that allows them to interact with new practices. A teacher preparing to implement innovative teaching practices may find that new teaching situations may develop new interactive connections that, in turn, develop and create new experiences.

The Effects of Teacher Experiences and Learning

Johnson and Carlson's study (1992) sought to understand curriculum orientation. Two objectives were aimed at achieving this purpose: (1) to identify the curriculum orientation and teaching practices of selected Nebraska teachers, and (2) to understand the processes teachers used to examine their orientation. The orientation term was adopted from Carr and Kemmis' (1986) definition,

Educational theory must always be oriented toward transforming the ways in which teachers see themselves and their situations, so that the factors frustrating their educational goals and purposes can be recognized and eliminated (p. 130).

Johnson and Carlson surveyed home economics teachers (N=152) using the valid (80%) Curriculum Orientation Profile. The return rate was 61%. Three teachers from different parts of the state, who taught at different levels, were selected for observation and in-depth interviews. Two components of the research were the development of learning communities and the use of critical science action research. A learning community was composed of 45 teachers who incorporated writing, critical thinking, and dialogue into their classrooms. This group completed a reflective writing assignment on their learning and teaching. Critical action research assumed people were capable of changing repressive forces that inhibited their development, for instance, evaluating the sufficiency of a tradition to merit the continuation of a practice. Additional data sources were

lesson plans, course descriptions, teaching materials, principal and student interviews.

Data analysis used the constant comparison method of Miles and Huberman (1994) which is based on grounded theory and organizes data by looking for concepts, themes or categories, and developing inferences. One case study is reported.

Johnson and Carlson suggested that teachers had little opportunity to express their thinking or reflect upon their practices. Teachers were consistently unable to articulate what they thought in a clear manner. They failed to distinguish between conflicting orientations and regular orientations; consequently, teaching practice is seen mostly to be a technical orientation, which does not require cognitive processing or critical consciousness. Classroom observations of teachers' practices verified the technical orientation. Teachers did not reflect on their practices to see if their practices were compatible with what they said they do. Teachers were unaware of their orientations until the survey process. It appears the survey questions influenced teachers' responses by developing a focus on their orientations. One teacher said he believed he had a cognitive orientation, yet observations revealed he exhibited a technical orientation. Another teacher concluded that she must get her beliefs in line with her teaching. The authors concluded that some teachers can practice teaching with a technical orientation without reflecting. In other words, teaching can occur without obvious prior thinking.

Wilson's (1994) study spanned a three-year (1982-85) period and attempted to describe how teachers confront selfmade constraints in themselves and school. The purpose of the study was to determine in what ways the writing project influences secondary English teachers. Connections were sought between teaching behaviors, the presence and/or absence of positions on teaching, and aspects of change in Data was collected from teachers who attended one behaviors. or more (summer) Iowa Writing Projects (IWP). TWP experiences emphasize tenets of good writing: (1) to create meaning, and (2) to discover what one knows. Teacher writers were expected to know and care about what they write and to write regularly on a wide variety of contexts. Data was collected through interviews, observations, and questionnaires. The questionnaire evaluated the teachers' assessments of IWP (1982-1985) on teaching. The return rate was 70% (80/115) of which 20 were selected for interviews. Four from this group were selected for classroom observations and individual case studies. Other data collected were teacher journals, papers, student assignments and work.

Wilson, as an IWP instructor, was familiar with many of the teachers in the study. This familiarity helped find the three females and one male teacher for the case studies. Their teaching experiences ranged from 4-16 years, and they taught at different locations and grades.

Each individual teacher became known through his/her journal writings and questionnaire responses. Wilson argued that, in a broad sense, teachers' beliefs about writing,

teaching, writing practices, and change are determined from their comments. The interviews were used as meaningful follow-ups to clarify comments made in the teachers' journals and guestionnaires.

Wilson found that changes in thinking are voiced early in the program, and he notes changes in their writing and teaching of writing. One teacher's reflections exemplified the changes. This teacher wrote, "I cringe at the shameful practices that arose from my thinking that writing is a product to be evaluated, taught in steps, and marked for correctness." Another teacher reflected that her experience with the change process was one of resistance, followed by conversion, and then a state of continued uncertainty. Her uncertainty grew out of the realization (reflection) that the way she was teaching was unproductive and harmful, and she had to make changes. All the participants reported that the change process was like a religious conversion, using terms like new birth, awakening, a new way of relating, and a sense of euphoria.

The observation data included information on the participants' use of summer workshop resources in their practices. The teachers affirmed the workshop's worth and talked about the change process, which was dramatic and often traumatic. Wilson found, during extended field visits, that teachers had simply transferred practices learned in the workshop to their classroom; no new activities or practices had been created. When teachers had run out of project activities, they would revert to past practices. Wilson

suggests that the teachers found that the idealized workshop atmosphere and the classroom atmosphere were not the same. What they could do in the workshop was a struggle to translate into their classrooms.

Wilson argues that teachers found change to be difficult. Two teachers' new practices involved not correcting every spelling error, which was different from their high school colleagues, who corrected everything. Consequently, they could not go against teaching what was expected by the staff. These responses lead the author to conclude that teaching behaviors involved choice.

Wilson found teachers changed their practices by giving students a choice of writing topics. Rather than writing on a topic chosen by the teacher, each student wrote on the basis of his/her knowledge. This practice grew out of an experience or reflection that students need to write about something they know about. Wilson found that implementing this practice was not easy, as teachers reported the difficulty of grading so many papers in one day.

The author found that teachers also had difficulty in maintaining change and consistently being "gung ho." Many teachers reported becoming discouraged and feeling the pressures of state standardized testing, as well as keeping students on task and grading papers. Some teachers saw dissonance in their teaching as an opportunity to articulate and examine their practice. The author argues that dissonance made their teaching more permeable or open. For example, the author found teachers maintaining practices that they knew were weak educationally and not in keeping with their changing practices, which were made on the basis of controlling students, not learning or teaching. The workshop developed confidants with teachers and the researcher that continued into the school year. Having someone to listen and talk was a very positive ingredient for reviewing experiences and progressive teacher learning. This support of teachers is a very important element both for the workshop and for professional development.

The last section analyzed was case studies written by teachers during the observation phase. One teacher wrote very candidly, describing her experiences as beginning when Wilson's observations began. She explained that it was only when he observed her that she used the workshop's writing activities, causing her to change. Otherwise, she taught traditionally and did not use the workshop activities. Wilson admitted he was unaware of this coercion until he had read her story. He did see some changes but attributed them to other causes. He thinks, in retrospect, that the teacher tried to bring her practices closer to those of the project. Another teacher reported that she stopped apologizing for her lack of attention to her students' needs by providing new experiences to and for students to bring about better student writing and learning.

Wilson joined forces with the case study participants to present their stories at a conference. The purpose was to report that teacher's learning about their own teaching is changeable (permeable). The changes resulted by the

workshops, follow-up observation, comradeship, case studies review and conferences allowed for new experiences, which influenced and fostered development (learning) and change in teachers. Accordingly, Wilson and the workshop teachers agreed on the success of the workshops in providing experiences that promote learning and change.

Overall, Wilson found that the longitudinal character of the study revealed a relationship between experiences and teacher (learning) development.

The Hewson and Kerby (1993) study attempts to shed light on science teachers' conceptions of teaching and learning. They defined conception as understanding and interpretation of experiences concerning themselves. The study's purpose was to define the conceptions of science teaching by high school (12) Biology (4), Chemistry (4) and Physics (4) teachers. The teachers had five or more years of teaching. Six teachers were selected for interviews after responding to the Conceptions of Teaching Science Survey (Hewson, 1989). The interview consisted of 10 events that included instances and non-instances of science teaching. An instance involved showing a teacher a written event and asking if there was any science teaching occurring and then giving reasons for their answers. The results were presented in two ways: (1) as individual teacher and (2) across individual analyses of comparison and contrast.

Corrigan, a Chemistry teacher, in response to the CTS interview, revealed two main goals: (1) to help students appreciate how the natural world works by using science to

understand and explain the world and (2) to prepare students for college Chemistry. Corrigan maintained that these goals would help students become better consumers and citizens. Also identified by Corrigan as important were (1) to identify science as observing, analyzing, forming opinions, and (2) to demonstrate that science is "hands-on" labs, field trips and demonstrations. Corrigan defines "field trip" as an opportunity for students to explore, play and interact with materials on their own.

Corrigan's Theme Analysis Grid (TAG) identifies four themes: science, learning-learner, instruction-rationale and teaching. Hewson and Kerby found Corrigan's goals for learning matched his activities and relationships with the natural world. On the theme, learning, Corrigan linked clear objectives to hands-on work, which he considered vital. He felt that students had varied experiences and learning levels, which he addressed through his instructional choices. For instance, Corrigan recognized that there are differences between higher and lower levels of learning and that these require different teaching strategies. He used a mix of instructional strategies: demo, labs, and lectures, explaining that lectures were necessary, since the lecture is the major form of teaching at universities. Thus, Corrigan adjusted his goals and teaching and was informed by his understanding of science and learning. Corrigan's themes were well balanced, multi-dimensional and complex.

Jonas', a chemistry teacher, three themes were straightforward and less complex. His conception of meeting

students' needs was through organization and structure, on the one hand, and wonder and curiosity on the other. Among his themes were tensions, which are contradictions between what he said and how he taught. One tension evident in Jonas' teaching was requiring organization and structure that was equal to recipe learning, such as algorithmic lessons and activities, while at the same time there was a great need to develop spontaneity in students. Jonas' tensions were also found in his teaching and theme on teaching and learning. Jonas' TAG analysis revealed that he rarely made statements about science. The closest he came were comments on the importance of reading and math skills in science. Hewson and Kirby concluded that Jonas recognized science only for its utility.

For Ms. Sorenson, a physics teacher, conceptions of science teaching consisted of closely interwoven themes. The themes of science and learning both occur through the process of discovery. She used techniques, such as questioning, hands-on activities, and silent demonstrations to involve students. She believed that students require concrete manipulation of physical objects and that student learning takes place by the ingestion of knowledge rather than by memorization. Hewson and Kerby found that Sorenson maintained a well-integrated program of conceptions and instructional strategies and found no tensions or contradictions in her themes.

A fourth teacher, Mr. Venturi, taught biology. In contrast to the other teachers, no connections between his

themes and teaching were found because several tensions existed. Venturi linked everything he did to his preferred form of instruction, which was lecture. Although he wanted students to develop their own questions and design experiments, he did not plan accordingly but offered as excuses the constraints of limited lab space and large classes. Another tension was his emphasis on teaching scientific terminology rather than other topics. A third tension concerned coverage of material, which he felt was not necessary because science changes rapidly. Venturis' last theme related to the relationship between instruction and learning. Venturi said he used discussion as an interaction for his lectures, but only when he had time. The authors concluded that Venturi did not link his themes to learning. For whatever reasons, Venturi did not mention learning explicitly in his interview, choosing instead to emphasize his instructional side.

Hewson and Kirby concluded that themes and grid analysis are good ways to organize a view of teachers' conceptions of teaching and learning. Teachers' thoughts surface on the knowledge that bears upon their experiences in the classroom. As such, the themes reveal a teacher's complexity. Each teacher's conception of teaching science is noticeably different from another. As simple as the themes are, the contradictory potential in teaching is lessened as teachers find ways to reduce complexity by constructing ways to allow the flow of information. Themes form the basis for their decisions and the relationship between teachers' thoughts and actions. It isn't simple. Teachers are not mechanically predictable. Each teacher responds in a different way. Thus, the interaction between thought, experiences and action is not one-to-one. There were a number of actions structured to allow teachers to operate quickly and effectively. While it was expected that themes influence actions, it wasn't readily apparent in the assessment of any particular teacher.

Barrow's (1991) study was part of a science and mathematics teaching project. The purpose was to take a close look at how a teacher conceptualizes his/her role when implementing an elementary science (6th grade) curriculum. Barrow wondered how teachers are affected by influential factors when trying to implement a new curriculum. Teachers have an image of their role, which consists of an array of practices and is determined by a specific context. Barrow argues that change is possible because of the interaction between a teacher's learning and the context. Teacher change occurs as the teacher encounters dissonance or perturbation. Teachers, on becoming aware of the need to change, may make a commitment, project themselves into the vision, make cognitive and overt changes, and be reflective throughout the process. Barrow suggests a model that indicates three factors salient to the change process: vision, commitment, and reflection.

Barrow found that teachers' conceptions of teaching and learning changed at several levels. For instance, a new level (change) is reached when teachers have a wonderful

teaching idea and occurs when teachers question their own teaching and then reflect on the answers. According to Barrow, this is reflecting-on-action, when teachers review, reconstruct, reenact, and critically analyze their own performance and those of their students on an evidential basis for ideas (Shulman, 1987).

A team of four researchers worked with an elementary school as part of a collaborating project to produce model classrooms. The first goal was to work with teachers and enable them to be change-agents in schools. A second goal was to investigate teacher conceptions, teaching constraints, and examine how these factors affected classroom practice and student learning.

Researchers visited the school once a week for several weeks. This was considered a time in which teachers and researchers could talk about what was going on in their classrooms and schools. They discussed issues that teachers perceived as affecting their practice. These conversations were audiotaped and transcribed. No classroom observations occurred during this trust-building stage. After several weeks, three teachers volunteered to be in the second phase of the research, which was for them to interact with the research team members as they moved through the science and mathematics enhancement program. The intent was to see how teachers went about implementing the program and delineated some underlying values associated with particular conceptions they held about teaching, learning and teacher change.

Two of the three teachers were described. A second grade teacher, Pam, had taught 17 years in a small rural school, which was the same one she had attended. The second teacher, Cindy, a 6th grade teacher, had eight years of experience. Both classrooms were observed for several weeks and the teachers were interviewed following the observations.

Barrow's data analysis and interpretations are expressed as assertions. One assertion is that elementary teachers see time as a scarce resource. As such, time becomes a constraint and limits the teacher's ability to reflect on teaching and learning. The curriculum is mandated, thus absent of teacher choice. Barrow found that Pam was moving quickly just to do what she had to do. Observations indicated that she allotted 30-minute time blocks where subjects had to fit. Pam said, "We have all those things mandated to us, and we don't have the time to do them all." Noting this, Barrow suggested that Pam lacked self-confidence and time to enact her teaching ideas, let alone is reflective. Similar problems were noted for other teachers in the school who had tightly controlled teachercentered classrooms. Barrow summarized the findings, suggesting that teachers do not have time to be reflective. Time is used to get ready for the next day. This focus on time suggests that teachers may not be reflective to make sense of their teaching or learn from experiences that favor personal growth due to perceived time constraints. A connection was seen between the lack of time and teacher confidence. Trying new ideas affects teachers' willingness

to share with other teachers. The environment simply may not provide time for reflective analysis.

Another consequence of perceived lack of time is that teachers are locked into time slots for each content area. An emphasis on reading skills turns reading into slotted times and unrelated seatwork. Children are passive, and the teacher does all the talking. Pam and Cindy shared the conception that students' poor performance on standardized tests was due to poor reading abilities. As such, they allocated more time to reading and less to integrated content. The author felt this arrangement added to the constraints of time. Change takes time, and these teachers did not feel they had time to even think about it.

A second assertion refers to teachers' conceptions that curriculum consists of discrete and separate subjects. As a result, teachers adopt traditional teaching methods that do not allow for reflection. Cindy said that she favored activity-based, hands-on activities; however, these activities were not observed in her classroom. Cindy's excuse was that she could not do more because the school did not provide the kind of materials she needed. She described the situation saying, "Science should be an activity thing, but for me it's a book thing." Observation of Cindy's classroom revealed drills, practice, guide words, guide sentences, and reading from the text. She used science time for reading, but not in content areas. Cindy later acknowledged the limitations but still clung to the idea that she needed materials. She explained that the reason she
participated in the research was her belief that she would acquire science materials by participating. Cindy reported that she had no time for reflecting about her teaching. Barrow argued that Cindy's presupposition kept her from recognizing that her past experiences could help integrate science and reading. Her actual methods, in fact, made a greater demand on her time and prevented reflection. Barrow argued that teachers couldn't have wonderful ideas unless they are reflective.

It was Pam who had the first "Wonderful idea" and shared it with Cindy and the other teachers. Pam's idea was to combine reading and a human body activity. She explained that the activity is science, art, reading and language arts. This freed her time to be reflective. She noted that she could then share her ideas with Cindy and others who were having difficulties.

Barrow concludes that Pam's reflective experienced gave her the insight to convert Cindy and provided an intellectual excitement that allowed Pam and other teachers as well, to be more receptive and confident of their own ideas about teaching and learning through reflection. It is reflection that leads to having a wonderful idea. Barrow suggests that promoting a wonderful idea is the first step toward becoming an agent of change. Pam and Cindy experienced an empowered state, the nature of which has implications for educational change and reform.

Barrow believed that Pam and Cindy's practices were altered by the interaction with the researcher and through

reflection. Pam's "wonderful ideas" were shared, led to changes in classroom practices, and developed the teachers' sense of power as agents of change.

Barrow's study represents a possible connection between experiences (learning) and teachers' abilities to gain access to their own thoughts and feelings about themselves. Reflective abilities appear to promote or initiate a change of image, which could further provide teachers with a sense of empowerment to try different forms of teaching. The empowerment potential may grow in teachers who are given opportunities to reflect on their practices and to learn from their experiences.

Yildirim's (1994) study was based on the assumption that teachers' theoretical orientations (beliefs) toward the teaching of thinking are one of two theoretical views, the content-based approach and the skill-based approach. A mix of the two methods is also possible.

Yildirim described the content-base based approach on studies involving expert-novice problem-solving and reasoning in specific knowledge domains. He assumed that content and intellectual processes were mutually reinforcing and that thinking is done within a particular content and is taught directly and explicitly, never as a separate course. The best way to improve student thinking involves encouraging student's to think reflectively rather than merely recite facts. The skill-based approach involves the development of skills and strategies of thinking outside of content. The skills are comparing, ordering, classifying, and predicting. Yildirim argued that the presence of either view presents contrasting methods for teaching and explaining critical thinking. The choice of view is the subject of this study. Yildirim questions

the teachers conceptions of their approaches to teaching thinking and to improving thinking. Do teachers conceive thinking by the content-based approach or as a set of skills to learn and practice? Do teachers have a clear orientation toward teaching thinking?

These questions are important, since teachers' perceptions of thinking inform their practice.

In Yildirim's study, elementary, middle level and high school teachers (N= 600) in New York City were sent a 20-item survey, which had a weak return rate of 46% (276). The breakdown by grade was elementary 38%, middle-level 28%, and high school 21%. Sixty-two percent of the respondents were female. Science teachers (13-17%) comprised the largest group, followed by teachers of English, Language Arts, Social Studies, and Mathematics.

The valid Theoretical Orientations Survey was scored on two scales, one for content orientation and one for skill orientation. Yildirim found those teachers' acknowledgement of the importance of knowledge for effective thinking was based on content. He said teachers strongly agreed that students think better when they have a thorough understanding of an issue or problem and that this is a necessary condition for higher order thinking. Teachers (66%) indicated that they viewed subject-specific content as a significant factor to improve student thinking but were divided on transferability, whereas teachers thought specific thinking skills are specific for different subject domains. Yildirim found, regarding skill orientation and teaching thinking, that thinking is composed of a set of specific skills. Therefore, he concluded that explicit attention to thinking skills are required.

Results for the skills-based approach had teachers (77%) favoring a direct approach to teaching thinking because they felt it was effective and because it was not hindered by subject matter. Teachers also believed it was helpful that students knew about the thinking processes, but the author was not clear teachers were sure thinking had to be taught in a systematic fashion. Finally, on the question of transversability, 62% strongly agreed that effective problemsolvers are effective in other areas. This pattern represented another divided view between content and skillbased approaches.

Yildirim found that by combining content answers and skills, a consistency showed for the statements found in the subscales. He suggested that teachers are neither content nor skill oriented. Rather, they are eclectic in their approaches to teaching thinking. The teaching methods are neither content nor skill-based because the basic ideas for each view are incomplete. Yildirim reflected that although teachers are in the best position to note the results of different teaching experiences, it is questionable whether they actually see the results or simply adopt them from an intuitive position. He further argued that it's not

realistic for teachers to subscribe to one conception because the choices are not separable from practice and have a modifying effect. A second reason suggests teachers are not well informed about theories. Teachers' mixed orientations are not grounded in understanding of the theories; rather, they result from assumptions that both approaches contribute to the development of thinking in students.

Yildirin speculated that if teachers are not grounded in the theories, then teacher orientations might remain weak or non-existent. In this case, the teachers' responses to the survey produce patterns that lead back to existing conceptions. As an alternative possibility, Yildirim suggested teachers were unable to state their conceptions when given lists of choices. This raises a concern when teachers cannot answer a question about their teaching but make up answers to meet the demands of a survey. Yildirin argued that a survey, at best, is a self-report, and there is no way to know if the responder is thinking for the first time about a topic.

Yildirin concluded that the study results had implications for teaching and learning. If teachers do not have orientations toward thinking, then it is understood why thinking is not taught regularly in the science classroom. The contradiction is that teachers very adamantly endorse the idea of teaching thinking skills in the classroom, yet do not do so.

Bennett's (1995) study develops a teacher profile that consists of a description of preservice and practicing

teachers' teaching and learning. It focuses on helping teachers to identify, enhance and make their perspectives explicit. The author argues that if teachers gain selfknowledge of their perspectives, it would lead to selfconfidence and success as teachers. The profiles grew out of the fact that often teachers are unaware of their own perspectives. Preservice and practicing teachers do not reflect on their teaching and values; rather, they react to situations.

Bennett's study, which explored teachers' decisionmaking and the teachers themselves, was part of a three-year program called Teachers as Decision-maker (TADMP), (Shulman 1986, 1987). It identifies six knowledge and skill areas that influence teacher decision-making: the nature of the learner, the nature of the subject matter, general pedagogy, specific subject matter pedagogy, school context, and self as a teacher. TADMP encouraged students to clarify their perspectives about teaching and to develop skills in reflective self-analysis. Bennett also suggests that social action skills and cultural consciousness core values are needed.

The process began in summer course-work and continued through the 15-week spring internship. The focus was on 68 middle and high school interns. There were 37 females. The age range was 23-51 years, representing individuals from a variety of first careers. The areas of certification were Social Studies (20), Science (18), English (18), Math (6) and

Foreign Language (6). There were eleven African-Americans, two Asian-Americans, and 55 European-Americans.

Data collection utilized concept mapping, interviews, reflective journals, videotapes of classroom observations, and stimulated recall interviews. The perspective concept consisted of beliefs, attitudes and values that helped teachers interpret and justify their classroom decisions and actions. In this view, Bennett believed that teachers' reflections were a lens through which teachers could perceive and interpret their teaching. Consequently, teachers' perspectives and practices are conceptually involved in their thinking and behavior. Perspectives are further connected to a model of teaching styles based on seven areas of a color wheel and described as inculcators, friendly scholars, scholar psychologists, facilitators of thinking, empowerers, nurturers, and friendly pedagogues. Each teacher's teaching style was defined in the findings and analysis sections. The author suggests that the purpose for using the color wheel is to metaphorically illustrate teachers' perspectives to make them visible and to avoid any semblance of a hierarchy.

A second phase of the study involved 35 preservice teachers from the 1992 cohort. These student teachers were interviewed about their beliefs on teaching and asked to describe their educational histories. On analysis, the researcher applied the model and found that the teachers' perspective selections were identical. A second activity placed the teachers into small groups to apply the color wheel perspectives to case studies on teachers from previous

TADMP programs. Teachers used the same guidelines to identify their primary perspectives. The results were described as individual cases. For example, Ronald was an African-American engineer who started teaching math in a small Christian school, but after one semester, he left to pursue an engineering career. After several years of working as an engineer, he entered the TADMP program. Ronald's initial perspective description was that of a friendly scholar. He said, "A good teacher cares about his or her students. Good teachers have a strong knowledge of what they are teaching and the ability to get this information across." Later, Ronald reduced the friendly scholar perspective to the third position and raised the empowerment and nurturer perspectives to the first and second positions. He wrote that he was empowered because he had a definite desire to build self-esteem in students. He saw himself as a nurturer because he planned to have caring and warm relationships with his students, and he saw himself as the friendly scholar because in math, the students must learn content in a manner that is fun and relevant. In Ronald's words, "The inculcator emphasizes knowledge without relevance, and this is not me." Ronald's fall practicuum took place in two advance high school math classes. At first, he thought his mentor was a friendly scholar, but she turned out to be a strong inculcator. She made very few connections between the subject and real world. She tried to direct Ronald's efforts toward the inculcator mode. Ronald wrote, "Humor and innovation weren't smiled upon." With each teaching

experience, Ronald affirmed that his friendly scholar perspective became stronger while understanding his mentor better. In his second placement, a middle-level math class, he was able to exercise his friendly scholar perspective with shades of nurturer and empowerment perspectives thrown in. His second mentor noted his creativity and inclination to do more for his students; for instance, he called parents when students were doing well.

Audra, the second case study and a chemist by training, discovered teaching when her company made her responsible for training. She enjoyed it more than working in the laboratory. After joining the TADMP, she identified herself on the color-wheel as scholar and psychologist perspectives. "Content is really important!" she wrote, ". . . also, the nature of the learner and the importance of being able to teach." Least characteristic of her is the inculcator mode, which controls by authority and not by developing interesting lessons. She said, "I don't want passive recipients but more active participants." After completing her first teaching assignment, her perspective moved to nurturer, or as she explained, she was more concerned that her students knew about risks of heart disease than being able to name the four chambers. When both case study teachers were asked what areas they needed work on, both identified the need to improve in the teaching of thinking.

The third case, Maria, entered the TADMP with a BA in English and Afro-American studies. The teaching attracted her because she felt it was the best way to deal with the

critical issues in the nation. Her perspective wheel pointed to the classic empowered perspective. She explained, "One of the most important things is to do your job, to teach your subject area, and to make sure after you are gone that the children have knowledge and skills for themselves." After her middle school experience, Maria saw she had more than one perspective. She explained that she had not accepted any particular perspective because, "It depends on what we are teaching and which perspective dominates. The subject and students make a difference," implying that her perspectives voluntarily shifted.

Bennett found that teacher empowerers and nurturers face the hardest role in their first years of teaching and leads to frustration and alienation. These teachers had strong social, cultural, and political views and wanted to develop them in their students, often clashing with the inculcator perspectives of their schools. Mentor teachers, who were aware of her perspectives and provided her with the opportunities to adjust, helped Maria.

Bennett found that Ronald's, Audra's, and Maria's perspectives were similar to several previous teacher groups. The distribution was about the same, which typifies the career change teachers. Though strongly committed to the teaching profession, they were not similarly committed to using reflective journals in learning to teach.

Many teachers found reflective journals as busy work, some looked forward to the stimulated recall interviews and others found them restrictive. The teachers detested concept

maps, but thrilled at the changes they saw over time. Most had difficulty completing their action research projects. Bennett felt that, considering the intensive nature of the program, this was not surprising.

Bennett concluded that Ronald's, Audra's and Maria's awareness of their perspectives aided them in being more reflective. As a result, they were paying more attention to their assumptions and, consequently, were better prepared to teach. Knowing their strengths and weaknesses became the focus for critical reflection on their practice.

The areas of the color-wheel provide a window where student teachers in TADMP can initiate and sustain reflections on teaching. The consideration of the seven perspectives helps students understand themselves, their peers, and mentor teachers. The wheel encourages a proactive approach to problem solving by framing problems into mismatched perspectives and conditions encountered in school.

A summary of the preceding studies is the underlying sense that teaching and learning is not totally accounted for by previously held conceptions. The Hewson and Kirby (1993) and Yildirim (1994) studies suggest that some teacher actions may have no basis in conceptions, or that actions may have several underlying reasons for operating, or that the teacher can be unaware that their conceptions are operating at all (Wilson, 1994). Johnson and Carlson (1992) found that teachers in a traditional form of teaching are not reflective on practice and did not articulate their understanding of teaching. This may be due, in part, to the way the teachers

are teaching. Their orientations may be vague and their reactions to everyday decisions may not have come from existing practices but may have been made in the absence of existing experiences. Wilson (1994) reported that teachers' reflective practices improved in a long-term workshop, a situation where teachers became more aware of their developing abilities to apply them. Barrows' study represents a possible connection between teachers' abilities to gain access to their own thoughts and feeling good about Reflective abilities appear to promote or initiate a them. change, which could further provide teachers with a sense of empowerment to try different forms of teaching. When reflectivity was not observed, teachers struggled to synchronize their practices. Barrow (1991) suggested giving teachers the opportunity to reflect on their practice and experience in order to meet challenges and become agents of change.

Teachers in Wilson's study found support was generated through contact, workshop, fellow teacher conversations and the researcher, and when it was not, teachers accounted for this lack as being due to the constraints of paper load, time, and the demands of covering the curriculum. Support for teachers, developed in workshops, was strong and useful to the teachers because the support countered constraints by promising something better upon returning to their classrooms. Teacher growth and development were implied through teachers' struggles to teach to their developing beliefs and goals. Teachers revealed difficulties in

maintaining an environment promoted by the workshop. Wilson affirmed that when the workshop activities stopped, the teachers returned to earlier teaching forms. This suggests that personal growth and professional development workshops or programs should not only provide activities or recipes for activities but must also include how to develop activities as well. In one instance, a teacher admitted doing the workshop activities only when Wilson observed. Later, the continued visits became instrumental in changing her teaching. She saw her practice was moving closer to her reflections and that she was using workshop activities without the incentive of a visiting observer. It has been noted in some cases that teachers monitor their teaching behaviors by choice, regardless of existing practices (Bennett, 1995). This suggests that new development is a potential when teachers are more self-directed and can experience growth through support and reflection.

Hewson and Kerby (1993) pointed out that reflection and actions are not true one-to-one behaviors; rather, a choice is made in the actions of teaching. Barrow (1991) found teachers who, upon having a wonderful idea (i.e., through reflection), could initiate change and subsequently develop new knowledge of teaching. There is a hint from each of Barrow's teachers that a lack of confidence and reflective ability prevents movement out of traditional forms of teaching. In case studies, Bennett (1995) raised the idea that a "color wheel" as a reflective tool is directive enough for teachers to use reflection continuously throughout their preservice experience, a feature which is very supportive of teachers, particularly with mentor teacher participation. Support of preservice and practicing teachers, through their involvement with the program, was developed by all studies. Consequently, teachers can be led and assisted in having experiences that lead to a wonderful idea.

Research on conceptions in teachers' teaching and thinking is closely associated to a specific context. As such, researching teaching is difficult and complex and depends greatly on the social context, level and content areas. This suggests teachers in the classroom be found in situations that are very complex and can be quite conflicting when practice comes under scrutiny. Bennett's study found differences between teaching and teachers at the high and middle-levels and practices that were used at one level and not at the other. Ronald, the math teacher, mentioned that the high school curriculum disallowed his ideas and that math could be a combination of content, structure and fun, which was more acceptable at the middle level.

Teachers are typically unreflective. The unreflective characteristic appears in studies where teachers' actions do not match. Data analysis disclosed that teachers' thinking processes are complex arrays of meaning not easily identified, especially when they can be hidden from the teachers themselves. As a result, there are gaps in understanding. Though the effects of teachers' beliefs are present, there is evidence that their beliefs are not as strong an influence in the classroom as once believed and are

subject to change or modification. We know that teachers who are unreflective can become reflective. This implies that by increasing their awareness of both their knowledge of teaching and their knowledge of reflection, teachers may be able to revise and change their practices. We know that teacher support during aspects of professional development invites more success (Bennett, 1995; Hewson & Kirby, 1993, Wilson, 1994). Self-direction is a personal growth aspect when teachers take charge of their own development. This suggests that beneficial professional development programs should have a strong element of personal contact for teacher support. This occurs when opportunities of choice are presented and when teachers can dodge the pitfalls of tension between needing and wanting to spend time learning and understanding their teaching (Lightfoot-Lawrence, 1997).

Professional Development of Teachers

Educational reform has raised the importance of professional development for teachers. The major premise of every report, council and national organization (AAAS, 1993; NRC, 1996; NSTA, 1993) advocating reform, restructuring, or to transforming schools emphasizes teacher change, which implies that teachers are part of the cause of education ills. As a result, teachers approach professional development and reforms with trepidation, consider reform a threat, or greet it with resigned acceptance. This is often marked by teachers repeating the "Oh well, here we go again," phrase. On another front, though, teachers are recognizing

that, perhaps, professional development and personal growth are their own responsibility. This means going beyond the mere enrolling in course work, meeting testing standards, attending in-services or pursuing another degree. Mevarech (1995) proposes there are links between professional growth/development and teacher change. The different links can impact teachers' practices and actions in the classroom. Conversely, actions can impact new learning subsequently, change practice. In these statements, are questions challenge teachers and researchers toward a better understanding of the interactions to unravel the relationship of teaching and teacher development, especially, when change in learning is a change in practice.

Personal Growth and Professional Development

A study by Johnston and Whiteneck (1992) serves to identify the prospective teachers' thinking regarding instructional practice and, in particular, how methods courses effectively change or extend prospective teachers' instructional philosophies and professional development. Instructional practices include all those things teachers do; however, for prospective teachers, their effectiveness to teach is contingent on learning. The purpose of this study is to look at prospective teachers' perceptions, the effect teacher education programs might have on changing or extending those perceptions, and to discover the reflexive nature between their perceptions and personal growth. The authors contend that teacher's knowledge regarding instruction and learners is diverse and appears to stem from many predetermined notions. The source of this knowledge is commonly associated with and constrained by prospective teachers' experiences. These constraints of knowledge may be extended to the teachers' slow development of pedagogical content knowledge. Johnston and Whiteneck argue that educational courses can serve to target and identify teachers' thinking and are positive professional development tools. The positive effects are noted in McDiarmid (1990),

If I do not know what my students are thinking, what ideas, experiences and beliefs they bring with them as well as what they understand about the ideas and experiences they encounter in the course, I will make decisions about means and goals blindly.

Identifying teachers' knowledge is addressed by a variety of means. Johnston and Whiteneck found that a number of investigators used videotapes of instructional practices that asked teachers to compare and contrast classroom situations. It was believed that viewing videotaped lessons would facilitate reflection on teaching and learning issues, and would be insightful toward identifying teachers' knowledge of teaching.

Johnston and Whiteneck developed three videotapes that contained a variety of instructional practices and experiences. The content of the set was (1) a five-minute tape on subtraction (elementary), (2) a six-minute fifth grade science lesson on data collecting and graphing, and (3) a six-minute constructivist-based lesson on problem solving. Teachers observed each tape and wrote comments about what they saw or what they interpreted from the film. They were given as much time as they wanted for their observations. The teachers' comments were collected and analyzed. Each teacher's comments analyzed (per tape) for emerging categories. The categories were instructional strategies, teacher questioning, student participation, and three lessor categories: problem selection, emotional beliefs, and mathematical activity. Reflective statements for each category were classified positive, negative or neutral. Johnston and Whiteneck argued that reflection statements identified teachers' knowledge of teachers.

The results indicate that the teachers (N = 32) had preconceptions regarding teaching and learning before they entered the class. For example, teachers made positive comments on student involvement (62%) and negative comments (82%) on student participation. These differences suggest that teachers distinguish between student involvement: when the student is active, attentive, motivated, and taking advantage of learning opportunities and student participation, no activity if the student is just listening or simply responding to questions with "Yes" or "No."

The reflections of the fifth-grade science and math integrated lesson found that students gave the lesson a negative response (67%). The negative comments were concern with instructional practices, teacher presentations, content issues, planning issues, and purposeful learning. The authors said that the lesson involved a misconception episode that 78% of the prospective teachers did not see. Since a

majority of the teachers did not see the misconception situation, the authors suggested this was the result of teachers switching lenses and projecting the feelings of fifth graders rather than viewing the lesson as teachers. The teachers' statements took the form of what students should have done, which excluded themselves.

The constructivist lesson results raised categories that the teachers had not mentioned before on other educational situations. The new categories were inquiry, gender issues, peer teaching and collaborative learning. The largest category was inquiry, with 21/36 positive comments. The authors concluded that these teachers (25%) did not approve of this form of teaching mathematics.

Johnston and Whiteneck's analysis addresses the common categories found in the three lessons. The researchers found those teachers frequently mentioned student participation and student involvement; however, their comments shifted with each situation. Comment over the student involvement category comments was rated low for each situation, with the subtraction lesson the highest and the constructivist lesson the lowest.

The authors concluded that using video-situations are an effective way to identify teachers' knowledge of teaching and to explore and discuss the professional development implications in the methods course. The findings surpassed current understanding of teacher knowledge, and while some teachers' previous experiences are in conflict with current objectives in teaching and learning, others are not. The

authors suggest that consideration of teacher thinking provide an opportunity for teachers to have an active role in their educational experiences and personal growth.

Investigators Bell and Gilbert (1994) described a three-year project involving New Zealand science teachers. They found in the literature suggestions that teachers had initiated their own professional development and had done so at their own expense. The purpose of their study was to investigate the development of teachers as they learned about new teaching activities and student learning. Forty-eight secondary teachers were involved over a three-year period in the Learning in Science Project (LISP). The three-year group consisted of teachers of all grade levels with a wide range of experience.

The data was analyzed on the basis of three types of teacher development: professional (cognitive and action), personal, and social, and was composed of support, feedback, and reflection components. The amount of development was explained in terms of three positions: initial, second and third. The initial position describe teachers just beginning to become aware of problems and expressing dissatisfaction with teaching. The second position dealt with continued development and restraints, particularly the feelings and concerns of behaving differently in the classroom. Areas of concern included fear of losing classroom control, amount of teacher intervention, covering the curriculum, knowledge of subject-matter, meeting assessment requirements, relationships with students, and teachers' self-evaluations.

The third position refers to teachers' growing sense of empowerment. Their emotions were encountered when, as teachers, they had to stand back and watch students grow in a constructivist atmosphere. They watched and tried to maintain a sense of competency as students did more, and they, as teachers, did less while at the same time giving voice to feelings and ideas without feeling uncomfortable.

Bell and Gilbert suggested that the category of social development and context contained an aspect, which considers isolation of the teacher in the classroom as problematic. Teachers tend to isolate themselves from other teachers, safe from comments, criticism, and demands to change. In this situation, teachers do not receive support or feedback. The authors defined collaboration as consisting of weekly meetings where teachers share what is going on in their classrooms, describes new activities, and give support. According to the authors, this collaboration promoted confidence. Teachers suggested they would continue working together or initiate their own research.

The authors suggested that professional development activities encouraged new ideas and found teachers competent to pursue their own directions. In this circumstance, teachers were encouraged to become teacher researchers and to value and find out more about their students and their teaching. As a result, Bell and Gilbert noted that teacher learners viewed professional development as learning and not remedial. The research activity was instrumental in developing support groups and reflective abilities. Talk in

the meetings involved the sharing of new activities and the voicing of concerns for the success of other teachers in the group. The authors concluded that the successful meetings were dependent on a supportive atmosphere. Teachers were encouraged to try new activities, to contribute, not to feel put-down, to share their concerns publicly, and to feel supported.

The authors note that the main phase of this section of professional development is connected to self-motivation. Teachers developed and adapted new activities, shared experiences, and evaluated their teaching. Teachers were reflective over the entire scope of their practices and not just on student control and management. Their actions matched their new theoretical ideas and their personal growth enabled them to initiate professional development activities. Teachers expanded their experiences, were open to new ideas and classroom practices, and cognitively attended to feelings associated with changes that were initiated by the purposeful inquiry of and investigation into their own teaching.

The authors' concluding statements emphasized the importance of personal development as an essential ingredient of teacher development and must precede it.

The pace of professional and personal development change is often restrained by outside influences. These restraints can be cultural (Tobin, 1990) and emotional -feelings about teaching (Cochran-Smith, 1993). Development is promoted when teachers are able to talk to each other about what they do in the classroom. Bell and Gilbert note

that teachers' continued efforts to change were based on feeling better about themselves and the learning outcomes in their classrooms. The teachers' sense of empowerment grew steadily in this development process (Cochran-Smith, 1993).

A study by Cross (1995) defines teacher personal theory making as professional growth. Teachers used action research as a means to identify their personal theories, to describe elements of their practices related to those theories, and to determine how to further evaluate their practices. In addition, the study searched for links between teacher reflection and practice.

The Cross study refers to Doll's (1993) work which concluded that the reflective process requires teachers to think critically, inquire into their practice to evolve personal theories, to share their theories with the public, and to create community sharing, inquiry and understanding. Personal theorizing (Ross, Cornett, & McCutcheon, 1992) describes a process of relating ideas and action toward an enriching experience. Teachers use their knowledge, skills, beliefs, and values to make sense of their situations, to take appropriate actions, and to assess the impact of those Cross defines action research (Mckernan, 1991) "As actions. a dynamic professional development process that is a form of practical reflection related to curriculum." Teachers practice differently because they think differently, hold different beliefs, and possess idiosyncratic conceptions of what those beliefs mean to his/her work. The purpose of this study sought to contribute knowledge about the complexity of

teachers' work and acknowledge the resources teachers bring to their practices.

The data were collected during a graduate curriculum course involving twenty-three primary and secondary teachers, principals and librarians. Cross found that the teachers felt the course was mostly about writing or developing curriculum; however, the expanded aim was to engage participants in thinking about curriculum planning as a teacher activity of choices, priorities, intentions, interests, and assumptions. The group of teachers held a traditional view of curriculum development and had virtually no experience with personal theorizing or action inquiry.

The guiding questions for the study and the course were, "What inquiry methodologies can lead teachers to a different set of assumptions about curriculum and knowledge?" and "What methodologies can provide an example of how these new assumptions connect to practices and actions?" The questions are framed around teachers' abilities to (1) move toward an integrated perspective about curriculum, themselves, knowledge development, and their practice/action, (2) analyze their own account of professional practice and theory, (3) think about their own knowledge and their ability to articulate about their practice, (4) illuminate how they consciously and tacitly use knowledge, skills, beliefs, and values to inform their practice, and (5) see themselves as curriculum theorizers and knowledge-makers. The study models Cornett's et al (1990) three-phased personal theorizing components. Students identified their personal theories, how

theories are manifested in practice through data collection, and a resultant action plan.

To start, Cross (1995) modeled the three-phases by explaining her personal theories for the course design. The phases were four weeks apart. Phase one accessed teachers' personal theorizing through action research. Teachers were asked to develop a curriculum theory chart which detailed their beliefs, knowledge, values and assumptions, and which of these they anticipated would guide their curricular decisions, choices, and practices. The constructed charts were then shared with the class. During this period, teachers kept reflective journals.

The second phase required teachers to review and analyze their curricular work for personal-theories-in-use. They used lesson plans, transcripts of videotapes, observation reviews by supervisors, and personal logs. Once these were analyzed, the teachers created a report of the findings as a reflective tool, linking curriculum, their knowledge, their practices and actions. As a final step to phase two, they described places of congruence and conflict among the theories and practices.

In the final phase, teachers posed questions and thoughts concerning their theories. The questions related to dilemmas, contradictions, possibilities and issues, which led to an action plan the teachers identified as an inquiry regarding personal theories or curriculum. Cross evaluated the total chart for logical connections, thoroughness, clarity, and matched it against Doll's (1993) ideas of

organization, reflection, creativity, and communication. Cross found that, as a result of personal theorizing through action research, teachers could express ideas, reflects upon them, creatively articulate and communicate them. Teachers said they were more conscious about their practice, reflection, and actions because of their own analysis, and sharing and communicating with others.

The findings suggest that teachers centered their thoughts on three themes: (1) teachers as curriculum theorizers, (2) broader conceptions of curriculum, and (3) teachers as inquirers who inform and are informed by knowledge. Teachers reported they did not consider themselves curriculum developers, except by serving on some school committees. Their thinking shifted when the course linked curriculum development to professional development and practice. One teacher saw her development, in becoming more willing to engage in reflection, research, and theory making, as helping her to become the teacher she had imagined she could be. Another teacher reported that it was satisfying that his practice was matching his personal theories. Mikki, another teacher, related how important it was for her to move her tacit beliefs from the abstract to concrete and gain a greater assurance about her teaching. Cross suggests that teachers are finally recognizing that they hold, develop and use their theories, and feel good about it. One teacher wrote, "My actions and philosophies weave together." Another said, "I can examine my theories because they intersect and overlap. They are interwoven." A strong point is made that

these teachers are very vocal about being better prepared to talk about their practices.

Cross argues that many participants in the study who were engaging in personal theorizing and action research elevated their perceptions of themselves as professionals. Teachers' thoughts and decisions were significant, and they recognized the responsible roles they had with curriculum. Cross suggests that these teachers were gaining voice, feelings of empowerment, and developing a fuller understanding of the relationship between knowledge, their investigations and the inquiry process.

The author concluded that teachers are able to use their personal theorizing through action research to think about themselves as inquirers and be informed by knowledge. Teachers question their views on the forms of knowledge, its derivation, and how it informs them. For example, Alexis, on curriculum reform, resolved that it was equally important and significant for her to examine her theories, to research them and not to follow the status quo. Heather wrote that she felt less directed by the theories of others and was using personal theorizing to critique and analyze. The author concluded that teachers were better able to think of their own professional development as one of responsibility and decision-making.

Personal theorizing resulted in teachers thinking about themselves as professionals and about learners in ways they had not considered before. One teacher, Grace, wrote that personal theorizing caused her to want to learn more.

Similarly, another teacher, Beth, became aware of her beliefs and the crystallizing of her curriculum thoughts. Reflection played a role in their personal theorizing. Beth felt it helped her, and she could share her work with colleagues. Another teacher, Ted, saw reflection as having continuous value and as necessary for his growth as a professional educator. Priscilla said that reflection was her main form of personal development.

There are several implications for teachers: the recognition that knowledge can be derived from various experiences, the ability to critique and analyze, the desire to learn about self and practice, the importance of participating in the inquiry process, and the desire to collaborate.

Cross's summary suggests that (1) teachers hold personal theories in different forms, (2) they hold implicit notions of curriculum that shape their decisions and practice, and (3) teachers engage in personal theorizing as a result of action research. The author argues that personal theories have an impact on how teachers view knowledge and how they question and stop accepting the knowledge of others without inspection and the demand for validity. Teachers have become inquirers and knowledge makers. Of great significance, however, is the generation of dialogue on curriculum, action research, and personal theorizing that creates a framework for reflection, thinking and inquiry. The benefit of this process is the special empowerment it gives personal experience. This connection goes beyond

theories, researchers and practitioners to the community within which these traditional parties of inquiry relate (Clandinin & Connelly, 1995, p. 425).

A study by Cornett, Yeotis and Terwilliger (1990) looks at relationships among teachers' thinking, beliefs and professional development and its effects in the science classroom. The authors relate curriculum factors and teaching decisions to how teachers may positively affect student's reactions and learning. It was speculated further that if teachers do not have explicit knowledge of their theories, what impact would the revelation of this conceptual framework have upon their conception of themselves as teachers? The authors found that teacher thinking literature and language concepts realistically represent teacher classroom practice. Calderhead (1987) and Shulman (1987) contended that the research community should work with practitioners to develop a clear picture of what the practical pedagogical wisdom of teacher's look like. The authors also found that reflection and belief studies in the science classroom were weak and have not improved, particularly for middle-level science teachers.

The purpose of the Cornett et al. (1990) study was to illustrate a teacher's perspective about science teaching and to determine the effects of becoming aware of teachers' perspectives through the viewpoints of a university researcher and a university supervisor. A naturalistic approach was used to study Lori, a first year 7th grade

science teacher. Cornett observed ten two-period classes, followed by interviews

Lori was a recent graduate of the Kansas State University Teacher Program, with a major in sports medicine and a minor in biology. The second author of the study was her university supervisor (Yeotis) and was responsible for Lori's participation in the research. Yeotis affirmed that Lori met the qualifications for the investigation in terms of beliefs, the ability and willingness to reflect openly and the potential to teach effectively. Data consisted of lesson plans, lesson outlines, curricular and instructional papers, in addition to field notes and classroom observations. The trustworthiness of the data was established by Yeotis' description of Lori's beliefs (theories) that guided her practices and experiences (practicuum) and by meetings between the supervisor, researcher and teacher, which took place to discuss the descriptions of her practice and complete the triangulation to everyone's satisfaction.

Data was interpreted and served as a basis for subsequent formal interviews in which Lori was asked to discuss her beliefs and practices. It was determined that Lori had seven personal, practical theories that guided her practice. These were identified by Yeotis but phrased in Lori's words, "... seeing more than hearing ... talking in kids' terms ... science learning is fun ... higher level learning ... very disciplined class ... reinforced concepts ... help student save face ..." The theory, seeing more than hearing (Lori), is labeled as visual

learning by the researcher. For example, Lori demonstrated magma movement by crouching down between two students who were holding their arms over her. She slowly pushed up through their arms, simulating magma pushing up through the earth's crust. Another theory of Lori's is the need for a very disciplined classroom. According to the authors, Lori believed she required a tightly managed classroom for effective learning. Both researcher and supervisor suggested that Lori's management bordered on regimentation. She required students to place homework in a basket, to be quiet on entering the room, to be in their seats when the bell rang and to follow safety rules and directions.

The researcher and supervisor felt Lori's personal theories did not reflect some practices, particularly personal theories using higher order levels of learning and teaching. Lori, who argued that the researcher and supervisor did not make enough observations to see this practice over the school year, disputed this.

The authors argued that Lori's desire for a controlled classroom, at times, interacted with a second belief of helping students save face, suggesting that more than one belief (theory) was operating. Lori knew that, on occasion, two and three theories could be engaged for certain situations. The researcher and supervisor concurred and noted further that, regardless of the situation, her theories guided her practice and, most importantly, influenced the students' opportunity to learn science. The authors point out that prior to their study, Lori did not articulate her theories, and as a result, did not have an overview of those beliefs that affected her practice. The inability to articulate beliefs corresponds to findings by other researchers (Clandinin, 1986).

The authors suggest that Lori's instructional decisions were guided by her theories. In fact, some theories were more dominant than others and might have reflected a belief system that would remain apparent throughout her teaching career, or could become developmental if reflection were to become a part of her thinking and application. Accordingly, the authors felt Lori's potential development was possible when she was more aware of her belief systems and personal theories for curriculum and instruction. This system would significantly guide her decision-making and, in turn her teaching. Lori could now examine, reflect or take action on her practice.

The above is not an exhaustive review of the professional development literature. It is, though, a selective one, which links teachers' thinking, personal theorizing, perceptions, experiences, personal growth, professional development and self-improvement studies. In fact, the majority of the reviewed research on perceptions is comprised of professional development endeavors (Hewson & Kerby, 1993; Wilson, 1994). The professional development studies illustrate the complexity of teaching and meaningful personal growth and professional development (Bell & Gilbert; Cross, 1995; Cornett et al, 1990; Johnston & Whitehead, 1992). Johnston and Whiteneck demonstrated teacher interns were unable to perceive a misconception in science when they took the role of the student rather than that of the teacher. Johnston and Whiteneck suggested these teachers were not thinking or reflecting over the appropriated theme. They argued that future teacher development would be facilitated through understanding of the connections to development.

Teacher support, feedback, activities and opportunities to initiate collaborative ways of working contributed to teachers' confidence toward personal growth and professional development (Bell & Gilbert, 1994; Cross, 1995; Wilson, 1994). Bell and Gilbert (1994) and Cross (1995) imply teachers-as-researchers may learn more about themselves, about teaching and about students, which suggests teachers may become more willing to try different professional development activities. Teacher learning came to mean professional development as teachers developed their beliefs, ideas and classroom practice (Bell & Gilbert, 1994; Cornett et al., 1990) and personal theorizing (Cross, 1995). Teachers, on becoming more aware of operating constraints, beliefs and teaching, gained a sense of empowerment (Cross, 1995) with confidence to question their previous positions to develop changes in thinking and practices (Bell & Gilbert, 1994). The sense of empowerment is comparable to selfmotivation or self-direction, when a teacher removes the sense of dependency on others for solutions (Fagan, 1989) and gains . . . a more potent and efficacious sense of self"

(Mezirow, 1991). Teacher research and reflection served both as the entryway to thinking of practice and to revising thinking of teaching. Cross found teachers were willing to act as researchers, to act after examining actions. It appeared that personal growth had become evident to them and could be vitalized by their sense of confidence (Johnston & Whiteneck, 1992), their development as inquirers (Cross, 1995) and their perspectives (Cornett et al., 1990).

Conclusions and Recommendations

The literature on critical and reflective thinking in teachers, teacher perceptions and conceptions of teaching can link these to meaningful teacher development. The connections are filled with the complexity of every day understanding of adolescent middle school student needs, middle school teachers who teach this group, and the learning that occurs for both teacher and student. Resnick (1993) concluded that children couldn't become thinkers unless teachers are reflective. But if, as the literature suggests, teachers are trapped in traditional forms of teaching, behind the closed doors of individual classrooms, they become isolated with undeveloped skills and unreflectiveness.

The literature also suggests that what might look hopeless is really a dilemma. Teachers should be required to take greater initiative to become more professional, so they can capitalize on the opportunities available for meaningful personal and professional development. These opportunities for development all seem to be connected to acts of self-

directed learning, which include collaboration, reflection and activities of empowerment.

It is, however, teachers' lack or avoidance of using skills that is an important concern. The failure to demonstrate thinking and reflective skills, to try new things, and to be creative are missing from the classroom and teacher. The important association between teachers' thinking skills and their practices and beliefs places teachers' need for awareness of these skills high on the list in order to understand their own needs. This understanding precedes the ability to develop meaningful change in personal growth and professional development. The literature suggests that reflective development and growth affects the teacher in a manner that eventually affects better teaching and greater learning by all, both teachers and students. The final connection is what the teacher does with teaching experiences to be that link to personal growth and professional development.

Just how personal and professional development for teachers is to be accomplished is suggested by Bell and Gilbert (1994), Cornett et al. (1990), and Cross (1995). Cross suggested that professional development activities, like teacher research, could provide personal growth. Bell and Gilbert (1994) and Cornett et al. suggested that a greater understanding of teachers' beliefs and reflection is needed.

All of the studies allude to three major factors that describe successful personal growth and professional

development. These are support, feedback and reflection. Surrounding these factors is the sense that teachers' desires can provide these through self-empowerment and selfdirection. Bell and Gilbert (1994) suggested that with social collaboration, teachers can grow professionally and personally. Cross (1995) agrees and suggests further that through action research, a teacher can experience collaboration and be more reflective. She also agrees with other researchers that teacher researchers can better relate their teaching behaviors to their existing and developing beliefs, particularly in periods of change that follow meaningful research. Cross mentioned that her results are similar to Doll's (1993), which connect teachers' personal theories to beliefs and values and note the empowering stance that teachers have once they experience that they have something worth saying. Cornett et al. (1990) found that Lori, a first year, 7th grade science teacher could not articulate her beliefs or personal theories until she became involved in the research study. Once Lori became aware, her activity increased. She followed-up her awareness with a variety of activities and action plans. This served to add to her sense of empowerment and led to greater innovation.

It is now suggested that clues on teachers' growth and professional development be marked by experiences that include reflection, greater and clearer thinking, support, feedback, and empowerment. It seems the studies that couple observation with feedback, conferencing with support, and involvement with collaboration developed the greatest amount
of change in behaviors. Observation of the changes may lead to a greater understanding of teachers' personal theories, knowledge of teaching and the interactions with students of those new experiences in teaching and learning. Thereby suggesting the development of a recipe for meaningful teacher personal growth and professional development.

CHAPTER III

Methods

Introduction

This proposal suggests that the middle-level science teachers' pursuit of personal and professional development is a journey, one in which teachers could, as Policelli (1987) argues, act as agents of their own development and involve their students, other teachers, and researchers in a mutual exploration about learning and teaching. This study will follow some aspects of the middle-level science teacher's experience by investigating the following questions: (1) How do middle-level science teachers plan and implement instruction? (2) What is the impact of "new" subject matter and/or a "new" instructional approach to middle-level science teachers' planning and implementation of instruction?

A picture of the middle-level science teacher is meaningless if studies are developed using limited data sources and knowledge of middle schools, teachers and students. This researcher has explored, described and learned about middle-level science teachers' approaches to teaching, implementation (actions and behaviors), and their thinking and involvement (experiences) with respect to personal growth and professional development in the teaching.

Access to teachers' practice involves the daily observations of two full units of instruction. The first unit was called the regular, or standard, unit of instruction. Typically, it was material the teacher had taught before and could be taught any part of the year. The second unit had to occur after the first unit. It had to be material or an approach to teaching that was new to the teacher. The observations of these units makes it possible to explain how the teacher plans, how plans are implemented and what actually takes place in the classroom.

To learn more about the connections between teacher and practice, conversations took place before or after the instruction of that day. The conversations were simply periods of talk, without the formality of an interview, but contained the elements of data gathering. Each teacher was aware conversations were data periods. The conversations varied for each teacher depending on when the observations occurred. Conversations with Judy usually took place after every class, since that was the teacher's prep period. There were some conversations that occurred before class, but were confined to short comments or questions due to limited time. Mary's conversations occurred as often as possible before the class. It was her lunch period and the time was divided between eating and helping students. Conversations with Mary occurred mostly after school, but often, during seat-work, Mary would talk with the researcher's during class. Pam's conversations were never long. She was always busy. Mornings were the best time, because Pam had three classes to teach after the last observed class. To hold a conversation with Pam meant working around Pam in motion. She would be moving about the room, getting ready for her next class.

Conversations also occurred at random times with all teachers in the lunchroom, in the halls, at school events and on the street. All three communities were small and confined to a few streets. Conversations were held with staff, principals and community members. The conversations generated a better feel for the climate of the workplace and for professional development.

Informal interviews, each of one and half-hours, followed the last unit. Interviews were aimed at clarifying the teachers' classroom experiences and talking about their thinking and behaviors over the activities of the unit, the teachers' interaction with students, and to find out if learning by teachers had occurred along the way.

The informality of the conversations and interviews was part of the research method to explore connections between teachers' actions and behaviors in and during instruction. The idea was to develop an easy working environment. Teachers were encouraged to take an active role in the research, through self-direction, decision-making and collaboration with the university researcher. Teachers were encouraged to frankly describe their experiences and discuss their thinking and beliefs associated with the actions and behaviors observed. The breadth of the research was about teachers' involvement in their teaching and in what ways they experienced their own professional development. The informality of the interviews was based upon open questions; for instance, "Can you tell me about your preparation for today?" From this point, the teacher's response served as

the foundation for the next question. If the teacher said, "I thought . . . , " then this was usually followed by another question, asking the teacher to tell more about what she thought about. As the interview proceeded, a situation (from observation) was described to the teacher. For example, a student had asked the teacher a question when the class was going over homework answers. The teacher answered the question for the student and the teacher continued to explain (three to four minutes) in greater detail and much more than the question required. The student asking the question was the only one that could hear the teacher's remarks while the class sat passively, not able to hear well what she was saying. After the interview question was posed, the teacher would be asked to explain more about the event. The reason for selecting this situation and for asking the question informally was to see what the teacher recognized about the situation without the researcher including any content topics in the question.

Teacher Participants

The participants in the study were three practicing female middle-level science teachers (Appendix A) who were teaching in rural schools in a Northwest state. Each teacher had six or more years of teaching and had been at the school for the majority of her teaching career. The present teaching assignments were distinct for each teacher. Mary taught two seventh and eighth grade science classes and two eighth grade mathematics classes, in a two-person team in a model middle school. Judy taught one section (eighteen students) of seventh and eighth grade science, History, English and Math in a small rural school. The total population of the school, K-12 was 108 students, of which 18 were seventh and eighth graders. She was the entire middle school staff. Pam taught five sections of science in two seventh, two eighth and one sixth grade in another rural school. The number of students in the observed seventh grade classes was forty-one. Though each teacher could rightly be called a middle level science teacher, their individual differences, school differences, community differences and student differences were enough to treat each teacher in the study as an independent case (Merriam, 1998; Patten, 1990).

Selection of the Middle School

The middle level was selected for this investigation, in part, because there is a lack of knowledge about middlelevel science teachers, the uniqueness of middle-level students (Adams, 1998), and the diversity of the teachers and community (Appendix B). The middle school was selected because the researcher has a familiarity with teaching science at this level, science teacher preparation is typically a secondary or elementary teacher education program (MacIver & Epstein, 1991), and there is a need for professional development for teachers.

Data Sources

Several data collection methods and strategies were employed: observations, video and audiotaping, conversations, interviews, questionnaire, lesson plans, journal, school and student papers. These will be explained separately in the case sections, not all methods were appropriate for each teacher.

Video and Audio Taping

Video and audiotaping received different responses to the researcher's requests to tape the classrooms (Appendix C) Judy's new superintendent/principal would not authorize videotaping in classrooms on his second day on the job. He avoided parental concerns, even though the school had no policy on taping and Judy said she wouldn't mind and felt her students wouldn't either. In contrast, Pam's school required letters and permission from parents (Appendix C, D). These were sent out and permission was received. In Mary's case, video and audiotaping was permissible as long as taping was in school and had no commercial use.

The video camera was set up a few days early to adjust students to its presence, to minimize obtrusiveness, and to work out potential taping problems. The teacher was asked to wear a remote microphone that connected to the videotape recorder. Previous experiences had found that students would take a few days to adjust to and accept the camera and researcher as classroom fixtures.

Observation of Regular Unit

To develop a comprehensive record on teaching, the data was collected over two observation periods. The purpose of the observations was to establish the context, setting and situation of the teacher. This was accomplished by describing what the teacher does regularly, to explore what the teacher feels and thinks about teaching and learning, and to hear what the teacher talks about during the teaching and learning (context). The observation data from the Regular unit was assumed to create a baseline set of data that could be used to compare with the New unit observation data. But, what did occur was expressed in the words of a well-known Bridge player said about playing a particularly difficult hand, "No plan survives the contact of the enemy (play of hand)." Certainly, teachers are not the enemy, or teaching the grounds for combat, but after the initial observation with two of the teacher's during the Regular unit, it was clear the Regular unit could not be used as a baseline.

Judy and Mary taught their regular unit and it was clear that new subject matter came up that was unfamiliar to them, essentially changing the regular unit to the definition of the New Unit. These teachers then taught two new units rather than one. As a result, their responses to the new experiences were potentially learning situations, and which paved the way to yet more experiences. More often than not, it meant the teachers were learning new content and new strategies, despite the fact that Mary and Pam were science majors. The idea of having a data baseline was dropped, and in its place was the observation of experiences of teachers in new learning and teaching situations. This resulted in a longer and richer observation period. The discovery of learning would positively suggest that the new teaching experiences had an influence on teacher development.

All teachers were observed in the same manner, but the procedures invoke LeCompte and Preissle's (1993) idea that meaning is given to teacher actions, and subsequent explanation may be different for teachers. This study may gain new insight about the factors and impacts of these experiences on teaching, thinking and learning. It was important that language and meaning be clarified early in the study. Not only is understanding the teachers fundamental to the study, but this understanding determines the direction of each case. When different meanings emerge, the researcher awareness allows further probing and exploring.

This researcher found it extremely important to take a participant observer stance (Denzin & Lincoln, 1998; Whyte, 1984) which is necessary to develop a level of trust, familiarity, and comfort between researcher and teacher. The researcher became an equal in Hopkin's (1994) and Loucks-Horsely et al, (1998) "Critical, inquiring friend" sense. Gaining teachers' trust may be the only way the researcher can question and challenge their assumptions, giving them a chance to talk and reflect more freely about aspects of their teaching and thinking. Each teacher accepted this section slightly differently. This discussion will be expanded in the individual case study section.

All observation periods began with informal conversations and were followed by post-instruction, unstructured conversations (Seidman, 1998; Spradley, 1977, 1979). The conversations consisted of open-ended questions to foster the teachers' free expression of their thinking, their intentions in teaching and planning for that day and for the ensuing days of the unit. The highlight of the interviewing sessions was to develop and maintain a friendly and easy-to-work-in atmosphere. The conversation questions will reflect this intent. For example, an opening conversation with Mary occurred as she just finished class and the researcher joined her in cleaning up. The conversation began with, "Did you do something a little differently today?" Whatever the teacher said in response was used to form more questions later in the conversation.

Observation of New Unit

The second observation period was about the teaching of a new unit, which was to be defined by the teacher. The unit was to deal with new subject matter, new teaching strategies, or the teacher might simply adapt materials, teach a different chapter from the textbook or even design a new unit. The units took one to three weeks to teach. Conversations with the teacher preceded the new unit, to have the teacher talk and explain how she selected activities and developed lessons. Observations and interviews of the teaching followed the format established in the regular unit. The interview questions, though open-ended, were more direct and had a narrower range of topics. Each teacher was asked

similar and general questions, both as icebreakers and as openers to the interview process. Such questions may be: "Can you tell me about your goals and objectives for today's lesson?" "Tell me more about the goals?" "What did you like about today's lesson?" "Tell me about what you were thinking as you planned for today?" "What did you suppose were the students' need for such a unit?" "Anything about the lesson that might be revised?" These questions were aimed toward gaining greater insight into teachers' thinking and meanings for their actions and behaviors during the teaching of new material. This unit and daily activities potentially contain one or more new experiences that provide opportunities to discuss and discover any underlying factors or impacts on the teacher. A teacher, in this case, may give meaning to different actions, thinking, and reflections. The experiences and dialogue may also contribute to a teacher's awareness on what is done and said. It is possible, too, that nothing new would happen.

Other Data Sources

Other data was collected from the school. Open-ended interviews were conducted with administrators and teachers, and informal conversations were held with students. The student conversations occurred often during the periods of activities, and the researcher was able to walk around in the classroom without disturbing the teacher or students. The conversations were audio taped with a remote microphone and transcribed. At other times, conversation and activity

information was written, when taping wasn't possible. The administrator and teacher interviews were informal with the intent to explore each individual's understanding of the school's atmosphere (climate), personal growth and development. The nature of the questions allowed for free expression about schools and roles within them. The main idea was to have teachers and administrators talk about the climate on personal development without the researcher's initiating the topics.

Interviews

There was a post-instructional interview that followed each unit. It was conducted in an easy conversational tone and friendly (critical) manner some weeks after the second unit. The aim was to learn about each teacher's teaching, thinking, to confirm and not confirm observations and developing interpretations that may have originated during the observations and conversations.

Conversations on the other hand were talk that centered on the teachers' expectations for day and the thinking surrounding the days' events. If teachers could not meet after each class, the conversations were rescheduled and became a part of the next day. The conversation length was undetermined and lasted as long as the teacher was willing to participate. During the conversation period, the researcher was committed to being helpful to the teacher in the room. The intent was to maintain and improve the sense of trust while developing a routine for talk to build a collaborative relationship in order to gain insight into the meanings the teachers give to their teaching and learning experiences. These sessions were audio taped and transcribed.

Summary of Data Sources

This study emphasizes the naturalistic setting (classroom) to learn about teaching from the perspective of the teacher (Yin, 1989). In addition, there was the attempt by the researcher to develop an emic perception, or insider's perspective (Gall, Borg & Gall, 1996; Patten, 1990).

The data collection strategy was to place the teachers in their classrooms and utilize the experiences of teaching into tales of how the teacher lives and relives them. Access to the teacher's source and range of thinking was developed through classroom observations and interviews which probe the teacher's understanding of the experiences and serve as a way to further identify elements within his/her experience in the context of the middle level science classroom.

The classroom observation and interview data was extensive and critical to this study. Each teacher was observed over thirty days and for an average of two periods per day, with the exception of Judy who only taught one period of science. Judy's class length was fifty-five minutes, Pam's fifty-two minutes and Mary's fifty minutes. The average hours of observations for Pam and Mary were sixty and fifty-three for Judy.

An idea to increase the scope of the study was having the observations spread out the school year. For instance, Mary's first unit was taught in the fall and the second unit was taught in the winter two and half months later. This scheduling was not possible for the other two teachers.

As a result, this naturalistic study (Guba & Lincoln, 1994) involved multiple-sites (Firestone & Herrior, 1984) and used multiple data-collecting techniques, which according to Whyte (1979) is what researchers should be doing if in-depth understanding is possible and if the researcher wishes to understand the language of the teachers as they teach.

The multiple-site, multiple-method strategy satisfies the demands for triangulation (Denzin & Lincoln, 1998) of the collected data. It adds rigor to findings by comparing data collected by a variety of methods, a variety of sources and in a variety of contexts. Teacher involvement is a data enhancement strategy that opens a lens to the theoretical perspectives (Gall, Borg & Gall, 1996) of teachers. Multiple methods also correct biases that occur when the researcher is the only observer (Glaser & Strauss, 1967; LeCompte & Preissle, 1993), reduces the researcher stance (Wolcott, 1992), begs the understanding of a slow developing analysis (Richardson, 1992) and is the mode to advance inquiry (Huberman & Miles, 1998). Triangulation also provides a means to counter-check knowledge and to confirm or not confirm emerging themes, patterns, or conflicts in data.

Data Analysis

This study is both descriptive and exploratory in nature. The data collected was analyzed using the constant comparative method (Merriam, 1998; Miles & Huberman, 1994). This process involved organizing the data by concepts to describe and reduce data by identifying themes or categories. The storage and retrieval of emerging themes and patterns was assisted by NUD>IST. Inferences were drawn, and grounded theory (Glaser & Strauss, 1967) and hypotheses emerged when the data was analyzed.

The number of observations, interviews and field notes generated a large amount of data. Consequently, it was particularly resistant to tidy processing methods. One way to handle large amounts of raw data was through weekly transcription. The transcription passages were explored for emerging patterns and themes in order to categorize information (Glaser & Strauss, 1967; Strauss & Corbin, 1990). The interview data was used to clarify teaching as it related to the research questions. The impact on the science teachers' professional growth is connected to the teachers' sense of self-direction and reflective experiences, which constitutes learning in teaching.

The emerging themes and researcher interpretations address the specific research questions regarding selfdirection, factors and impacts on teachers' personal and professional development. This study's questions were addressed by how each teacher interacted within their environment and reveal how each teacher coped with the new

experiences. The data was given close inspection to identify conflicts and to confirm emerging themes and patterns. The Qualitative Data Analysis (QDA) (Nud>IST) program allows multiple passes of the data. Thus, a constant comparative method is used (Miles & Huberman, 1994). The information allowed the researcher to introduce topics in the daily conversations. The talks inquired about the teacher's teaching and thinking, about the activities and things that did or did not work and what could have affected it. This approach provided information and insight concerning the teacher's awareness and understanding of her actions and behaviors as they related to teaching, thinking and learning, and in addition, addressed the factors and impacts of emerging themes that might be affecting personal growth.

Two teachers taught two or more sections of the same class, and some comparison was made. Different settings with different students offered the potential to teach differently. Whether the teaching was the same or different could pose many questions of "Why?" and "How?" and become the basis for greater understanding of the factors and impacts on teacher thinking and teaching.

The question concerning self-direction, planning and implementation of instruction was addressed by the close inspection and analysis of the teacher's language use in the classroom and during the conversations. This followed Bogdan and Biklen's (1992) argument that language and words are used to uncover important insights into what and how the teacher is responding to new experiences. An analysis of the

teacher's selection of words and phrases with students in the classroom communicated changes in thought, ideas, and instruction. Teacher interaction with students and curriculum activities often implied reflective thought (Pea, 1993). For example, a passage may be spoken with passion or emotions that reveals a cognitive path to underlying motives which may or may not be discovered consciously by the teacher.

When a teacher talks, his/her language also serves as a basis to determine and understand the factors associated with the impact of professional development and personal growth. The data source was the conversations between teachers and the researcher and the transcripts of the video and audiotapes. The conversations were truly collaborative, very informal, with give and take by both parties. These conversations allowed the teacher to be comfortable enough to reveal her thinking, confidence about teaching, sense of classroom dynamics and the limits of her risk-taking. The conversations represent the teachers' successes and failures, as well as representing insight to their learning.

An element that language revealed was the extent of the their reflectiveness. Words and phrases indicated teachers' capability for self-exploration, whether or not they saw teaching as dynamic, whether they were committed to developing life-long learning skills by actively building their own knowledge and by conveying to others that they were vitalized by what they do because the tasks they undertake are grounded in activities of practice.

The Researcher

The researcher of this study is a retired teacher of grades 3-16, with twenty-five years of classroom experience. The researcher regularly taught three to five classes of middle level science and one or more high school classes in Physical Science, Chemistry, and/or Oceanography. Third and fourth grade science classes were taught periodically. The researcher served as an elementary science specialist for seventeen years. Prior to this, he had earned a bachelor's degree in Zoology and Chemistry and pursued a M.S./Ph.D. degree in Marine Biology/Invertebrate Physiology. After three years in the doctoral program, the researcher left his studies for a teaching assignment in Alaska. A Master's degree in Marine Biology was completed. The researcher has also had eight years experience working with preservice and practicing teachers, both in the field and in the university classroom.

The researcher is a strong advocate for middle school and middle school teachers and continues to be active. He believes that middle-level science teachers' content knowledge should be equivalent to that of high school standards, but strongly connected to understanding students at the middle school. Teachers at the middle-level should earn certification through teacher education programs that contain experiences designed specifically for them. The researcher has been very active at the national level in the development of this type of middle school certification and teacher education program. The researcher's views concerning life-long learning is integral to his stance that teachers should take personal responsibility for their own education and professional growth and development once they begin teaching. The practicing teacher should be motivated and self-directed to pursue learning that raises his/her skills so as to positively affect student learning and achievement.

Biddle and Anderson (1986) point out that researchers come with unique backgrounds that include similar and dissimilar experiences, ideological commitments, and interests on certain issues and concepts which make it very difficult not to make assumptions or to exercise choices. The researcher is aware that his advocacy for the middlelevel teacher, school and education will constantly place him in a position of being biased. By being constantly on guard for potential bias, the researcher, as the primary instrument, kept careful records and detailed observer comments. The researcher's beliefs are clearly present. As a result, great effort was made in this study to be nonjudgmental in reporting what was observed in the classroom.

A researcher's constructivist beliefs can have an effect on data collection and analysis. They may bias observations, particularly in observing non-constructivist teaching. This problem required the researcher to avoid judgmental comments and to record any negative feelings that were associated with viewing a lesson.

It is recognized that during interviewing the researcher can affect teachers' responses and the subsequent

data collected. A simple change in voice, tone, or body language can affect unwanted perceptions and responses from a teacher. For this problem, the researcher also maintained a daily research journal of his actions and reactions with attention to the events of the day.

CHAPTER IV

Results

Introduction

In 1973, Harris Beechertt wrote a book entitled, "But, What Do We Do Instead?" directed toward elementary teachers. In his book, Dr. Beechertt asked teachers to rethink what they were doing, and he challenged them to do something new or different. The text of Dr. Beechertt's question could just as easily be asked of the middle school science teacher, "What are you doing?"

The purpose of this study was to investigate how middle school science teachers think about their planning. How was their planning implemented? What is the impact on their teaching when they are doing and trying something new or different? What are the impacts of teaching a "Regular" unit (any organized teaching) and a "New" (untaught) unit of instruction on a teacher's personal and professional development? All teachers have an opportunity, through each day's teaching, to turn experiences into elements of their own development and evaluate those experiences, asking the question, "Am I learning to be a better teacher?"

Teaching, in light of teacher development, is a continuous learning process. This learning process is about teaching experiences and learning that originates in the needs of the classroom and not about workshops, activities, or programs. It is more a personal ethic, a way to gain self-learning throughout a teacher's working life.

The research results of observations of three teachers, Judy, Mary and Pam will be described in depth. Each teacher, school district and geographical area has been renamed to protect the anonymity of the participants.

Case Study

Judy

Description of Teacher and Classroom

Judy's education background consists of a Bachelor's degree in Elementary Education and a Master's degree in Reading. She has taught twenty-two years in a small K-12 rural school (approx. 200 students) in Alaska. She presently teaches a seventh and eighth grade Science combination class that includes nine seventh graders and eight eighth graders, of which six are girls. Judy's teaching experiences include self-contained third grade, third/fourth combination, fifth/sixth combination and sixth grade. Since 1992, she has taught middle-level English, History and Math and the high school science teacher taught science. Judy began teaching the science class in 1999. This made Judy the entire middle school staff. The science curriculum rotated yearly between Life Science and Physical Science. The observations occurred during the Life Science year.

Judy's class was housed in a 20' X 25' room that contained no noticeable science equipment, running water, gas or electrical outlets. The desks were older and lift-top, which provided a place to store books and papers. Next to Judy's room was a storeroom that was shared with the computer room directly on the other side. The storeroom had a sink and water, and a collection of older, single copy science textbooks. For science equipment, the teacher could borrow from the well-stocked high school science classroom, just two doors down. In the north corner of Judy's room were five web-connected computers.

Judy was very active throughout the year and during the observation period with elected and assigned extra duties that centered on the middle level. This required a balancing act between her teaching responsibilities and her extra duties of planning and organization. Extra duties included the seventh grade lunch program, which required monitoring and assistance. The class planned menus, bought groceries, cooked, served lunch and cleaned-up for 130 elementary students and teachers every Friday. Judy did some of the cooking and made sure the clean up was completed. On one occasion, her lesson plan included notes to check the oven to see if the cake was done, refrigerate the pudding, and get out the cookies. She left the room to do this, but on leaving, she told the class she had to check the cakes for tomorrow's lunch. Not once, while she was gone, did the students neglect their work.

The extra duty with the 8th grade involved operating a snack food and school supply cart. Students could buy a snack or school supplies at lunchtime or during the day. It was nothing to have a student enter Judy's open door during

science, to serve him/herself and leave. The eighth graders were responsible for every aspect of the operation, including the ordering, selling, inventory and accounting. Judy's responsibilities saw to it that students did everything and that no problems were created with the snack foods. During the observation period, Judy chose to close the store for two days when a snack wrapper was found on the floor, rather than in a trash can. She claimed that throwing the wrapper on the floor violated the cart's operation policy and explained it that way to the class. Judy was also expected to substitute for teachers and coaches who traveled. On four occasions during the study, Judy lost valuable prep time by monitoring Computer, History or Home Economics classes.

Judy was deeply involved in her profession and with her students. She reported that she rarely left school before 6:00 PM, and often came in on weekends to prepare. The school and community had come to expect their teachers to be like Judy. On more than one occasion, the researcher heard community members say, "I don't know how she does it. She works hard at that school." Asking Judy why she was doing it, she replied, "There is not enough being done for the middle level. There are activities for the high school and nothing for the middle level." Asked about the choice of activities, luncheon and store, she said, "There are things just as important as the academics, and that is the whole child . . . they have to make real deadlines, be on time and be very responsible . . . things they don't learn in science or history."

Observations of Regular Unit

Judy's regular unit, "An Introduction to the Microscope and Single Cells," started on a cold Monday morning in November. There were no preliminaries. The class began promptly at the bell, with the teacher calling students to face her. "Face me," she said. The phrase, and obvious routine, quickly drew the students' attention to her. Judy then passed out a schematic, explaining they needed to become very familiar with the parts and function of the microscope, and a three-page reading handout. The reading came from the teacher's resource textbook, "The" authority. The class had no textbooks. Up to this point, inspection of Judy's lesson plan book did not show the detail of her teaching, just major headings. Asked what she did to get ready, Judy replied, she made some notes to remind her what she needed to do. Asked when she did this, she replied, "My husband and I come (to school) for a couple of hours on Saturday and Sunday."

Judy informed the students that they would be learning how to use the microscopes and identify animal and plant cells. In the same breath, she told them that science was her weakest class and said, "This is new to me. I know some of the things we will be studying in this unit, so I will be learning right along with you." Judy's admission to not knowing much about microscopes and single cells suggested a weak science content that is problematic to the study and for her teaching. The unit would not be a regular unit, one that she had taught before, but rather contained content elements that would be like a new unit. Before the researcher could

do or say anything, Judy came over to him and quickly began explaining her situation (her prep period followed the class). "I (Judy) want them (students) to know, I am . . . ah . . . I am working at improving and being the best I can." She continued speaking, this time, affirming her lack of science content. She explained, "My science content knowledge is very weak . . . there are a lot of things (i.e. about science) that I just don't know. I haven't taught science . . . except in the elementary, several years ago, but never as concentrated as needed in seventh and eighth grade science. My background is strong in many areas, but my weakest area is science," she repeated. Judy explained her use of the Biology textbook was the main resource. The microscope schematic and explanations she passed out came from this resource. Judy relied on the book as the authority. Often she said, "My book says . . . "

The situation presented the researcher with a concern-whether Judy should remain in the study. It was decided to continue because Judy's situation is not unusual. Reports on education have found that mis-assignment is a standard practice (Dozier & Bertotti, 2000), as it was in this school district, and particularly in rural schools in Alaska. Teachers are, in fact, often assigned to classrooms where their content knowledge is poor, yet it is expected that the teacher will manage. The decision to keep Judy in the study was the favor found in her willingness to share experiences. Her positive personal characteristics outweighed the negatives for keeping her in the study. She appeared to be an honest, easy and open person to talk and work with, all of which proved to be valuable assets in ascertaining the basis for her teaching. There was also the curious question and the unique situation of why a teacher with limited science content knowledge would "Allow" herself be observed in the classroom. The researcher resisted open speculation, but made a note to see what developed.

The students made no comment about the teacher's "New to me..." statement. They accepted the comment and waited for what followed. The students appeared to be excited about working with microscopes and were anxious to start.

After the brief introduction, Judy moved to the assignment on microscopes. She said they were to draw what they saw from prepared slides, first the letter E and then the onion root tip. Because of limited space, the class was divided. Half went with Judy to the library and half remained in the room with the aide. It was the only time the aide was used. In the library, Judy visited with and monitored each pair of students, asking them what they were seeing. She checked on how/what they were drawing, what they saw, asked questions about using the microscope and reminded them to use different magnifications for viewing an object.

Over the first few days, Judy was reasonably prepared, though it was not reflected in her lesson plan. Her lesson plan contained no detail for understanding the microscope. She had no information on the preparation of slides. Students ran the danger of making root tip slides that could only exasperate the patience of the young. The teacher was

unable to anticipate the nuances of what middle level students will or could do in making a cheek cell slide. She received information from the high school teacher on making an onion root tip slide by using the membrane found between the onion layers. Judy said, "Boy! Ha Ha Good thing. I would have told them (students) to put a big piece of onion on their slide." Actually, some students did. It took a while for students to find the membrane layer. In conversation after class, Judy said, "I feel comfortable (confident) enough to get help wherever I can." After the second day, Judy recognized that her students were having difficulty making a cheek cell slide, so she altered the assignment to using a prepared slide. Students were drawing blood when they scraped their cheeks and were calling red blood cells cheek cells. The teacher could not distinguish the difference either; however, recognizing this, she was able to maintain her original plan by getting prepared cheek cell slides from the high school teacher. She said, "Both students and I were learning what cheek cells looked like."

On the fourth day, Judy started the class with a review of the previous day and ended the day with a recap of what students accomplished. It looked like Judy was possibly trying something new. It wasn't in her lesson plans, or lesson notes. Later, in conversation, she explained that the review and recap were new. Asked to explain, she said, "The students remember better . . like reading something more than once (pause). That's good." In the post-observation interview, she brought up the topic of reviews, "I think the

reviews and recaps practice turned out great. I expect to use them throughout the year in science and other classes as well." Asked how she came up with the activity," Judy replied, "In English (class) . . . I was reading and I was thinking (actually reframing) how could I use this . . . ah . . . in science. You know Frank . . . it just happens and you do things." What made it great? Oh, they (students) learn. Well, it's like in reading. You start with, . . . Yesterday, 'What did we read about . .

The next day and over the entire unit, Judy's interaction with students occurred during all phases of her instruction. Judy talked to students as they entered the classroom. The conversations ranged from comments on a new dress to getting over a cold. "Do you feel better, now?" "Much better," said a seventh grade girl. "Maybe you should stay with me during PE," Judy said, showing concern. The girl agreed. During seatwork, the same interaction was evident and conversations included content, student well being, and opportunities to tell the teacher something. Laughter was part of the conversation on many occasions. It was a nice time for students to question the teacher, and most questions were on content. Judy would prefer they find out for themselves, by looking it up, but she would look, too. The follow up to these types of responses was good. The next day, students or Mary would have a solution or answer to the question, which was shared with the class. During discussions, the teacher let the students talk, question, share directions. Often, it was limited to

questions about the previous assignment or explaining a new assignment. Directions were usually one-way, teacher to student, but sometimes, a student would interrupt to ask a question.

In the midst of the interactions, Judy would occasionally pause. These were moments when Judy was seemingly "watching, hearing or sensing" something. She would pause and sort of "Shift gears," in her manner of speaking, to students. It was like seeing a light go on or a "cartoon balloon" that said, "New idea, new idea." Frequently, it caused Judy to pause in mid-sentence as she was addressing the class, "I want you . . . ah . . . to . . . instead . . . " and made a change. Judy later explained that she "Became aware students were in different places and having difficulty with the material, or were working slower than other students." She said she "Had to do something (reflect)." One solution let students who were not finished continue with the assignment, while students who were finished would move to the next assignment. Judy had another assignment ready, though it was not in her lesson plans. Asked where the assignment came from, she replied, " . . . from my book." In another incident, she had the potential problem of groups sitting around, biding their time when they finished an assignment. Judy's solution was to have each group share their information with each other. It worked well. Students readily shared information.

Over days five through eight the pace was steady. Students had an assignment every day. After the initial

assignment of three days with the microscopes, the unit followed with two days on the cell structures. The teacher directed them in drawing and labeling a generalized animal and plant cell. Taking time to draw the cells on the blackboard with colored chalk, the students followed by drawing on their papers with colored pencils. The assignment was divided into two phases, starting with the drawing of structures in large and accurately drawn detail according to Judy's reference book, followed by discussion and naming of the parts. Once the cell drawing was complete, the students were directed to label the cell's internal parts. Judy named and explained the basic function of each part. The students put the name of the structure on their drawings and wrote the function into their science notebooks. This continued until all structures (ten) were labeled and explained. The last few days of teaching were not reflected in Judy's lesson plans. Her lesson plan for this activity simply said, "cells." Days six through eight she continued the teaching of the cell parts. Student pairs were assigned a cell part and directed to find out more about it and to prepare to share the findings with the class. They were to have a nice, large drawing and written information. The handouts (from Judy's textbook), library and computer could be used for information. There was no homework during the activity, because they could work on the activity at home. She explained that the daily activities and reading were enough for them to do. During the work period of this activity, Judy kept busy helping students find information, though she

was not too computer literate. She relied on the computer teacher next door.

Students presented on the ninth day. During the reports, the teacher and students were encouraged to ask questions. Often Judy had students explain a term they used. Judy explained that it showed whether or not they understood what they read and shared. She did this with almost every pair. The finished work was not collected until the end of the unit. Judy said she had a "day-by-day awareness" of what each student had done. This was accomplished by her consistent and constant contact with students, talking with them as they worked, looking over students' shoulders, reading what was written, talking and sharing with them. Judy was questioned about these procedures. Were they new? She said, "No, not really, . . . that is . . . I did some (before) . . . but not for science. "I didn't have to for English and History, but I feel I do for science. I want to know what they know."

The tenth day was cancelled for a school play. The class had to attend the play, since an eighth grader had the lead role. The teacher explained it was going to be a quiz day but decided against that, and cancelled it all together.

The unit was extended into the next week for two more days. Judy adjusted the assessment by dropping the quiz in exchange for review and preparation of notebooks. Up to this time, no work had been turned in for grading. Asked about the assessment of the unit, Judy said, "I know where they are, I see their work every day." And what about the testing? Judy replied, "My lack of science content made it difficult for me (perception) to make a good quiz, or test. I couldn't tell if they were wrong. So their notebooks will do."

Observations of New Unit

The new unit began with a conversation before class. It focused on Judy's content area, "I feel better than at first; I know some things about invertebrates." She showed the researcher an older (fifteen years) high school biology textbook with a chapter about invertebrates. This was her unit. Her planning book revealed one line, "Invertebrates" and an assortment of page numbers. No details for implementing the activities were present. When asked about selection of the new unit, Judy said, "Seemed to be a good place to start and the next unit is vertebrates." What about planning? Judy replied, "Sometimes the main idea comes from the textbook, but I . . . added things." What things did you add? "I want kids to share . . . so I added posters and a discussion."

The first day of the new unit, "Invertebrates," was observed several weeks after the first unit in the winter quarter. The unit began with a brief introduction and an activity. Judy provided a 3 X 5 card to each student that contained five questions and common name of the invertebrate they were to research. The teacher then conducted a discussion about the five questions. She wrote the question on the blackboard, read it aloud, waited and then asked a question about it. She waited for hands, never taking the

first hand up, waiting until many or most hands were raised and even encouraging others to raise a hand if they knew the answer. Next, she would call on a student and say, "John, share with us what you know about invertebrates." After John finished talking, Judy would ask another student, what he/she thought about John's comments, or if there was anything he/she wanted to add. Judy repeated this procedure through the five questions. She involved all students.

In conversation later that day, Judy was asked to tell more about the discussions. Judy smiled, pleased with herself. She volunteered, "I think it went pretty well . . . I don't do this for science . . . that is until now . . . I do for reading. After reading something we discuss the story . . . I thought I would try it. I haven't used posters before, and I wanted to try . . . integrating some art and make the assessment easier and have them share. I taught art once." Tell me about integrating, the researcher asked. "Ah . . . it's my first time . . . for science . . . I think it makes sense."

This classification activity consisted of five questions to guide the finding of information about each student's invertebrate, creating a poster that consisted of a colored drawing of the organism, answering the five questions, and repeating the activity for two more invertebrates. All the posters were displayed and discussed at the beginning of the class. This time the teacher asked the producer of the poster to share what he/she found, including the answers to the five questions. Students were

allowed to ask questions of the reporting students, which they did. The activity was planned for three days but took four, with a new assignment given on the fourth day. Judy's lesson plans contained no details. She was asked about the lack of detail for the first activity. Judy replied, "Actually, part comes from the book and the rest . . . is just what I think . . . but . . . I know what I want to do."

The students worked diligently on the activity for three days. They made large colored drawings, labeling and writing out the answers on their posters. As soon as they finished one animal, they received a new card and repeated the activity. On the third day, the teacher ended the period with a question to the class, "What do you see that is common and different for the animals you have up here (pointing to poster)?" The question started a buzz, but they didn't get a chance to answer because class ended. A few tried to stay, but she sent them out. As the students left, Judy came over to the researcher and explained, "I want to see if the students can place the various invertebrates in groups. Then, we are going to look at each group more closely."

The next day (fourth) Judy reviewed (reviews were sustained) the activities and asked the question she had asked the day before. This time, the students did have time to answer. Their hands shot up! First, one hand, then several more hands went up. Eventually, all hands were up. Judy waited, surveyed the hands and said, "Good, everyone has an idea." Then she proceeded to ask each student what he or she saw as common and different. After all students had

commented, Judy had the students group the invertebrates, and they came up with five major invertebrate groups.

There were some mispronunciations of names and terms and misunderstanding on the placement of the marine worm group. Judy's book was not correct, but students had acquired information that was current and the corrections were accepted. In this section, students were actively acquiring information from other sources and were gaining knowledge that may be exceeding Judy's. Over the years, the classification schemes for invertebrates had changed. The students were using the new names correctly. Judy asked where the information had been found, and a student confirmed that the information was from a recently published book on invertebrates. The teacher accepted the student's explanation and had her "Share" the information with the class.

After the classification activity Judy was anxious to talk. She explained, "Everything was going well." It was "great." Much later she confirmed sustaining practices developed early in the unit, "There are many things I (Judy) started in the first unit I'm still doing. I'm finding that I can use my history, English and Math background pretty well in science."

The interactions between teacher and student and student to student revealed teacher concerns about the entire unit and became more evident in activities of days five through eight. Judy always added comments following the students' responses. In many cases, they were unique and
delivered with purpose. Judy explained that she wanted students to know she welcomed and appreciated their responses and their sharing with her and the class. "So I will thank them, such as, 'Thank you, Mark. You did very well with that question.' Or, 'Thank you Mark, you are almost there.' 'Thank you, Mark, for sharing that with us." Judy was asked to explain more. She said, "Well, . . . I just think it is important to recognize that they [students] are given some kind of answer without saying, 'Oh, very good,' or 'Oh, good job,' and say things instead, 'You [students] have put your hand up and you took a risk. So I thank you.'" Is that what you are doing when you ask students to 'share?' Or say, "Mark, will you share your answer with us?' Judy was asked if this was new, and she replied, "No, . . . some, I did it before, but not in science. I do it more in science, now." Is it deliberate? "Well . . . it's . . . yes . . . very deliberate . . . very deliberate . . . and . . . often times, if they [students] don't share amongst themselves or each other, then they think their audience is me. I don't want them to think that."

The activity for days five and eight required that students work with a lab partner. They were to pick a particular animal from one of the invertebrate phyla and read about it from some source. They were to identify a particular characteristic, make a colored drawing, and prepare to "Share" what they found with the class, explain why they picked it, and describe the importance of the characteristic to the animal. Later in conversation, she

explained that the activity was called the "Artist Role." Would you explain more about that? Judy replied, "Well . . . it's the artist role, because the student must look [integrate] at different levels. Well . . . they must combine reading, writing and art . . . ah . . . and science." Is it a new activity? "No . . . ah . . . it is I think this . . . it is something I found for science. from Nancy Atwell." At the end of the day, students started to show and explain the animal characteristic they had selected. In conversation afterwards, Judy explained that she had, ". . . read about a couple of animals they reported on . . . but the rest I learned today, too. Each day's lesson is new material to me." When the reporting was completed, the entire class and teacher had learned about the polyps of jellyfish, the tentacles of sea anemones, the cheliped (large) claws of crabs, stinging cell-nematocysts, jelly fish, and the ink jets of an octopus. Judy said, "The activity was 100% successful. All students completed the work . . . and they had a good time doing it." Asked if that was important. Judy replied, "Yes. I think the students were able to develop a greater understanding about invertebrates and demonstrated how and why. And they 'shared!' I insisted on that." She continued, "I wanted students to be able to talk with other students, share their thinking and not just be reporting or talking to me for approval."

On the seventh day a student ask a question of a student reporting about jellyfish, but wanted to tell a story

about his experience with jellyfish. Judy asked him if it was related to the topic, and he said it was. This started two days (days eight and nine) of jellyfish story telling. Surprisingly, twelve students out of seventeen had stinging experiences with jellyfish and one boy who confused a bite by a marine worm had to say something. Although most of the students' experiences had occurred in Alaska, five had occurred in other states and one in Mexico. The teacher picked up on the different locations, "Wait a minute, John . . . you said, where? Class, have you noticed that this is the fifth or sixth place where jellyfish are found." At the end of the first day of stories, Judy hurried over to my position and said, "Wow! Isn't that something! I . . . I never knew the kids had so many experiences . . . and they are all over the place." She laughs and says, "I didn't know that." The teacher also did not know that the last student, who was just dying to tell his story, was describing a worm that bit him when he was playing under the dock. It is a characteristic of some marine worms, which would be studied on day twelve, to have a proboscis and to be equipped with sharp jaws. Later, during the tenth day, students had worm stories associated with why they won't eat Halibut. In conversation, Judy said, after hearing students recount and share their experiences about Halibut and parasitic worms, "I don't prepare fish, so I didn't know that Halibut had worms. It was great."

During days eleven through thirteen, students contrasted and compared the two worm groups using Venn diagrams. Working in pairs, students found different characteristics of Annelids and Flatworms. Afterwards, each pair shared what they wrote with another pair.

On day fourteen, the teacher started class by reading the story about Athena being upset with the beautiful Arachia and turning her into a spider (Arachnida). The teacher used the story to transition to students writing their own stories about invertebrates. She cautioned students on what they should not include, "There must not be any killing or blood and guts." When asked about the blood and guts comment, Judy replied, "They get carried away. They write like what they see on television, the gorier the better . . . so I tell them to keep that out." Asked how she came up with this activity, Judy responded, "I think the students can read and write about invertebrates." You mean a science story? "Well, the facts have to be right." Is the activity new? "Well, for science." Students wrote for three days and turned in their papers, and that concluded the unit.

Post-observation Interview

The post unit interview was held at the completion of the study, several weeks after the new unit. In the interview, the questions were most often variations of the questions Judy and the researcher had previously talked about. In the interview process, Judy would have a situation described to her (previously talked about during one of the conversations) to refresh her memory of an incident, and she would be asked to tell the researcher more about the "Pauses"

she experienced during teaching. For example, a situation was described to Judy, where she was giving directions. She stopped and a lengthy "Pause" followed. Judy was asked to explain. She said, "I wasn't doing anything . . Oh. I mean, I was thinking . . I can even tell you what about." Okay. "I was thinking, maybe, I should change the assignment . . . or due date. Half the class was not finished with yesterday's . . . and I didn't want them (students) sitting around." So you changed the assignment? "Yes," she said. Where did the change come from? It is not in your lesson plans? "I had it somewhere in the back of my head . . . I had the assignment ready," she said.

Judy was asked about her group work. She explained it this way. "We did a lot of group work. I try to bring quite a bit of language arts with it. I remember trying to do some charts, Venn diagrams, and art to make sense of the phyla and so on. What I did was something I could understand myself, so they did very, very well." Judy affirmed her lack of content and that she didn't feel comfortable with the material. She said, "Other units where I was . . . What were they talking about? I went strictly by the book. . . . I pretty much went by the objectives in the book and whatever the book said it should be."

Judy kept the students very busy. Students had an assignment every day no sooner completing one, they were given another assignment to start. Judy was asked about the pacing. "I... they know that I will help them, and ... they will have time to catch up. I like that, and it makes

sense to them." Asked if that was the origin of the statement, "Does that make sense?" Judy laughed and said, "No, I say that rather than ask if they have questions. Kids never do . . .saying, 'Does this make sense,' requires only a puzzled look, or a hand to ask them (students) what doesn't make sense." Judy was asked if she had used this before. "Oh . . .no! Not for science!" Asked if she used it in other subjects, she said, "Maybe. But . . . I know what to do in English, History. It's just . . . Science that I don't know."

Judy was asked about the state of professional development in her school and community. Her response said it all, "Well, and I am being perfectly honest. This school district is not known for enabling you to grow professionally unless it is on your own."

Judy was questioned about students volunteering to tell about their jellyfish experiences. Judy was asked how this happened. "Sometimes, I will 'group' kids. I don't remember exactly what I did. Sometimes, I will walk around, read over someone's shoulder and say, 'Oh, this one is readable.'" For the jellyfish section, though, Judy expressed surprise,

I forgot that these kids go on vacations. They might have experienced jellyfish. That was by accident . . . somebody started talking, and then the next thing I knew, we are all going. I like it. So it was not by design, or out of control. I think we should go with it.

How do you decide that students telling stories was a good idea? She answered,

I think the kids decided that for me. I think that when you immediately see them start thinking about something that they could say, and you see all these hands going up, you have to stop and you have to address it . . . if you can make a connection with it, you will remember it.

On teaching the units, Judy remarked what it meant to her, "I always learn new things for the material. I have to say I'm not sharp with it."

Summary

This summary combines the results of the observations of the regular and the new units. It is based on the driving questions of the study, namely, "What is the planning and implementation of planning by middle level science teachers?" and "What is the relationship of this planning to each teacher's personal and professional growth?"

The two units of instruction and analysis have been combined because both units were based on new subject matter.

First, Judy repeatedly rejected the formation of rigid, formal, or scripted lesson plans. In both units, her lesson plan book entries were very brief or vague to an uneducated eye. The entries were limited to headings or topics, and devoid of details. She had notes and a list of things she had to do. The notes projected the lessons for several days by noting activities and readings that had to be prepared, materials to be readied, and items to bake or cook for Friday's luncheon. Judy was excited about the activities (her plans) when they went well. She exclaimed, "They [students] worked so well . . . they . . . they were learning." Judy explained, "They worked hard on all the assignments, completed all of them. Their final stories were pretty good . . . and they shared with each other." It's true that her students were very diligent about working. In both units, Judy could leave the room to cook, take out a cake in the oven, or go to the science room to borrow a piece of equipment and the students continued to worked. Early finishers of one activity, understood that another activity awaited them. Judy would have students share their work with another group. It was noted that these groups did in fact shared and paid attention as others explained.

Second, Judy built more in-depth science content knowledge through her experiences of teaching. There were several occasions, in both units, where she mentioned her science content knowledge was poor, horrible, scary, weak, non-existent or that she knew little about a topic. Judy affirmed that she had expanded her content knowledge while teaching about microscopes and cells in the first unit and invertebrates in the second, "Each day's lesson constituted some new material to me." Judy explained that she increased her skills by seeking advice and adapting her knowledge to help students learn,

I feel secure enough to grab help when, where, I can. My background (English and History) is strong . . . my science is not . . . but that's okay . . . because I can integrate them.

Judy integrated every lesson in the second unit with writing, reading, art and math, as well as science.

Integration started in the first unit with drawing cells in color and emphasizing accurate size, shape and location of the organelles. Judy used posters and story writing about invertebrates for assessment. She demonstrated flexibility and capitalized on students sharing of their experiences with Jellyfish and Halibut to learn more about each other and to work together.

In addition, Judy read, reviewed and completed the activities that students did. She used extensive student-student and teacher-student interaction to further the dialogue and sharing of information in discussion sessions that had a glimmer in the first session but grew into a major activity in the second unit. Daily review and recap activities were fully developed in the second unit. These served Judy in terms of her own learning, as student learning from specific tasks would outdistance hers. She listened to both students and peers, learning from both.

Third, as the result of teaching both units, Judy became better at applying new knowledge to teaching. The experiences of teaching both units opened avenues (new content) to self-learning. She demonstrated self-learning by to reading everything related the activities, by seeking help from a variety of sources, and utilizing the knowledge of the high school science teacher. She revealed a manner (pausing) to stop an activity in progress, in order to change its direction, its timing, or to drop it entirely in lieu of better, more reasonable direction. Judy used reflection and knowledge of students to integrate other disciplines with Science, to understand when change was needed and did so using positive student interactions that allowed their input while she was experiencing new learning and growth at the same time.

Case Study

Mary

Description of Teacher and Classroom

Mary's education background consisted of a Bachelor's degree in Education with majors in Math and Science and a Master's degree in Math Education. Her science background was primarily Life Science, some Physical Science, but no Chemistry or Earth Science. She had taught middle school for twelve years in the same school district and the last four years in this new middle school. Mary's assignment was one seventh-grade math class, one eighth-grade math class, two seventh and eighth-grade combined science classes and one homeroom. The classes averaged thirty-two students with equal numbers of boys and girls and seventh and eighth graders. The classes consisted of 12% minorities, of which 90% were Alaskan Native. A three-year curriculum rotation was Life science, Physical science and Earth Science. The year of the observation was the Earth Science rotation.

Mary's school was located in a small city, with many urban growing pains. The school was four years old and designed around the middle school concept of "Teaming" and "Houses." Mary's House consisted of grades six through eighth grades. Each house had two teams and each team had two teachers. Team teachers usually taught two academic subjects. Mary taught Science and Math, while her team partner taught Language Arts and Social Studies. Mary's room was large (30' X 40') by most standards, but was not designed as a science classroom. The desks, a combination seat and top, were often pushed together to give a slightly slanted, work surface. The room had one sink and electrical outlets along one wall. The remaining walls were cabinets, blackboards and a retractable "wall" that separated Mary's room from her team-partner's room, which was reasonably sound proof. It was not a distraction. There were no student computers in the room.

The proximity of Mary's team teacher meant that she had some contact with him every day. Their conversations during the observation periods were primarily about organizational matters. On several occasions, classes ran two periods for a long lab activity. This meant that Mary taught one Science class for 90 minutes. The next day, she repeated the activity with the second Science class. There was no observed common planning scheduled between teams. Mary spoke of having some contact with Science teachers in other houses, but conversations were not observed. The Science curriculum was the same in all houses and involved sharing resources and equipment. The units Mary taught in the study were units that all Houses would eventually teach that year. Teachers in the district developed Mary's first unit several years earlier. The unit featured monitoring the health of streams

in the area and consisted of an outline, activities, materials list and suggestions for teaching. Mary selected some activities, besides continuing the on-going measurement and study of particular local streams. The unit did not have a textbook. The second or new unit was a stand-alone module from GEMS, titled River Cutters.

Mary's extra duties were limited to classroom advisor to thirty eighth graders. They met every morning for a tenminute homeroom for roll call and general school information. Parent conferences were scheduled twice a year, one during the study. They involved early dismissal and three evening meetings. The School District dismissed school early so teachers could come back for the parents' meetings in the evening. Mary's elected extra duties were associated with volunteering time to students, before and after school and during lunchtime. Students regularly sought help for math and to make-up assignments after absences. Teachers were responsible to help the many students who were absent because of sports or academic events. Mary answered the absence assignment problem with a work section to pickup assignments.

The researcher always arrived in Mary's room during lunch and just before the classes to be observed. Mary would be trying to eat lunch, work with students, and get other work done. Between bites, she would help students and talk with the researcher. She was always busy during her lunchtime. There was always someone to help or prepare for her science classes.

Observations of Regular Unit

Mary's regular unit of instruction was an on-going, locally designed river and stream-monitoring project. She had not taught the unit before and it consisted of new subject matter. It was based heavily on physical measurements and calculation of a stream's health. The classes had just completed a two-day overnight campout to learn firsthand how to make measurements of streams. The camp was not observed, but a videotape was made and reviewed (days one and two of the unit). The camp stressed learning the characteristics of measuring a healthy stream or river. The student would be combined with the data collected previously (eight years) for the same streams. Data collection consisted of stream flow, current, pH, dissolved oxygen (DO), temperature, hardness, identification, population counts of freshwater organisms-aquatic insects, identification and count of plants and organisms, texture of bottom and description of human impact. Mary's water unit consisted of two field trips and completing a study of healthy and human impacted streams.

The first observation day began in the first week of the fall quarter. By this time, the teacher had been teaching and learning about her new seventh and eighth graders for about a month. There was no way to distinguish a seventh grader from an eighth grader.

The observation began with the teacher's acknowledging the researcher's arrival, smiling and informing him of the day's plan, "I feel a little out of it with this cold. I'm afraid my voice might not make it, so we will have a video, read and do study questions." Mary's lesson plan book did not have these activities listed, nor did she have any plans for the unit or for the second class, that followed. The second class was the same as the first class. What Mary gave the researcher was some brief notes written on the back of a piece of scratch paper. There were no details or explanations about the day's teaching

The TV was set up and a "fast write" question was on the overhead projector: "Give reasons for why people should have knowledge about watersheds and stream health." A fast write was an exercise wherein students wrote in their science journals until the teacher said, "Stop." The first class was given fifteen minutes compared to five minutes for the second class. Mary explained, "I like students to write often in science." It was observed that she explicitly emphasized students should be writing complete sentences and often they were graded. Mary's activities did not teach or help students to write better and there was no other mention of writing in class.

Mary ended the writing assignment by calling the class to attention. She called on students to read what they wrote. Students would respond and Mary would comment "Okay, right on," or she hesitated made no comment moved on to another student and another question. During this activity, Mary usually accepted what was said and moved to a new topic. Rarely did she add information, paraphrase student answers, or attempt to explain what the students said, although there

were many opportunities to do so. She left it up to the class to hear the answer when a student spoke. From the researcher's position, the students' responses were often difficult to hear. The video was the next activity, and Mary had some questions about the film. Before the video started, she had described what she wanted them to watch for. Marv had previewed the film before showing it. Her questions required simple one-word answers, which meant she was not consistent about writing being in sentences. Mary's lesson notes did not contain any questions, suggesting the questions were developed when she had reviewed the video. The class ended with a brief review. Mary admitted that the preview wasn't planned when she said, "We had time to kill . . . use." She gave final directions and the exclamation, "Don't miss school tomorrow, because it is going to be a fun day."

The teacher/researcher conversation followed the second class. The researcher observed that directions given to the second class were shorter than to those given the first class. Mary was asked to explain. Mary explained her planning for the two science classes with, "Here is what I use." Her notes showed no planning distinction between classes; however, her actions were very different. She allowed the second class five minutes to write compared to fifteen minutes for the first class. She expressed surprise, "I did? I wasn't aware of that." She then asked if the second class went better, smoother than the first. The student intern commented that it did, and the researcher did

not comment. Mary seemed satisfied with the intern's comment.

The fourth day, or fun day Mary had promised, revealed planning that brought three Biologists to class. They were involved in a local stream study featuring aquatic insects. Their teaching style was mostly show and tell, which motivated Mary to ask the presenters to adapt the identification of insects to the context of the work students were doing on stream health. Mary asked the biologists, "What are the relationships of aquatic insects to healthy streams?" The biologists replied, "They are indicators." This evidently satisfied everyone and the activity continued without comment. It was not clear that anyone knew what indicators meant, least of all Mary. Later, she lumped the insects into a large category, which suggested she did not. The identification activity began. During the activity, Mary and the biologists walked around and helped groups locate and identify various aquatic insects in their samples. During the monitoring, Mary came over to the researcher and affirmed, "I don't know anything about macroinvertebrates."

The fourth day for the second class was a modified version of the first class. Students wrote in their journals several minutes shorter than the first class and discussion was dropped. Mary had adjusted the directions to the class. First, she cautioned students not to move until all directions were given by the biologists. In the first class, student movement added confusion to the activity. The second class gained time for reporting what they found and more students reported. These students worked enthusiastically and at the bell, many stayed to work longer or to clean up.

The fifth day (Wednesday), students of the first class found overhead directions to write in their science journals. Mary was at the door greeting students and collecting field trip permission slips and reminding them of the fast write, "What did you learn about stream macroinvertebrates in the activity yesterday?" As the students wrote, Mary directed those students who did not have their field trip permission slips to call their parents from the room phone, which they did and the permission was obtained. The next activity involved a discussion of the previous day's activities. Mary had no prepared questions, but made them up as the discussion progressed, "Okay, what did you find yesterday?" After this brief review (she called it a review), Mary tried to encouraged students to help her plan the walking field trip for the next day. She divided the students into small groups and said, "I need your help to plan this and see what we can do in two hours." The groups were unable to help. Too many groups wanted to do the same water quality test, leaving several tests without testers. As a result, Mary had to drop the idea of students planning and she assigned groups to do particular tests. Mary was beginning to show her developing frustration in teaching the unit. When the class ended, Mary approached the researcher and the student teacher and with a pause and a sigh, she said, "Well, they are starting to get it. It's starting to come together. When I started this unit, I just . . . oh . . . everyday it's been a learning

experience. I had no idea what I was doing." The student teacher was quick to reply, "Yes, you did." And Mary said, "Well . . . I do, but it takes a lot of knowledge." This comment did not bring any explanation and the second class was coming in.

The second class followed the first class, with a fast write and permission slips. Mary started the discussion over the activities of the previous day. Students had many questions, while the first class had not. Mary allowed several student questions, and the students provide most of the answers, not the teacher. One student suggested that if the teacher read the answers to the questions it would go faster. Mary admitted that she hadn't written them down, "Well . . . because . . . because I don't have them written down." Later in conversation, Mary was asked to explain more about her questioning. She replied, "I thought that was . . . nice way to have students participate." The researcher questioned, whether it had gone as planned. After thinking and hesitating, she answered, "Ah . . . yes, I think so." She didn't explain more and moved away.

In the second class, Mary's directions about the field trip were clearer and more concise than in the first class. She moved the students through forming groups and the tests they would do. Students were asked to identify what to wear: warm clothing and shoes, no clogs. The first class had to be reminded and threatened if they forgot their coats. Later, the teacher commented to the researcher, "Well, that went pretty good."

The sixth day was a two-period field trip for the first class. The researcher had arrived early and found Mary getting ready for the field trip and was talkative about the content for the next unit, which would immediately follow the present unit because she thought the content was connected. The conversation continued, with Mary explaining what had been planned for the day. After the explanation, Mary was asked for a copy of her lesson plan. She hesitated, saying she only had this and presented a half-page piece of paper that contained randomly scribbled notes listing topics. Asked how this (half page of notes) would be developed, she explained, "I'm going to see if students remember taking measurements from the field trip camp experience." The students did not remember, forcing Mary to adjust her instructions and lesson by taking time to describe the water quality test procedures, which she read from the teacher guidelines. This took the better part of an hour and left only an hour for the field trip. The creek was a five-minute walk. It was raining. Mary was very busy helping various groups perform water tests, while other groups worked on their own. Students on their own had little concern for accuracy. Chemicals were not measured, just poured into the flask. The creek bottom was described with one handful of material grabbed from near the shore. Depth was measured by rulers read from any angle, and descriptions of surrounding vegetation were made hurriedly and from one location. The tests were completed, and students returned to school, and class was over. In the room, immediately after the field

trip, Mary laughed nervously, and said, "All of this activity . . . going to the field, is professional development." Asked what she meant by that statement, she replied, "I haven't done this before." Mary was showing in addition to weak subject knowledge, but also a limit teaching repertoire. In the same breath, Mary raised a concern about her effectiveness and student learning when she reflected, "We can do this better." Asked how, she responded, "I have to think about it." She vowed that Friday, tomorrow her second class field trip will be different. "I'm going to structure it more and assign jobs."

The seventh day found Mary ready to take a field trip with the second class. Like the first class, Mary wanted to find out what the students knew; however, this time, she dropped the idea of having students assist in the planning and proceeded directly to reviewing the tests that needed to be taken, and assigned students to do them. By reducing the dialogue, the field trip gained an extra half-hour. The students did very well with the field trip, remembering how to do many of the tests and being more careful and making accurate measurements.

After the field trip, Mary returned to her room. Before anything could be asked about the trip, she commented that the principal wanted her to attend an out of town workshop, and she would be gone Monday through Wednesday (Days eight through ten) of next week. Three other teachers and the principal would be going. The workshop was about middle school students' "Barriers to Learning." Mary did not

talk about the field trip in any detail, except she did smile and thought the class worked pretty well.

Mary's classes (Monday through Wednesday) were taught by a substitute. Mary's substitute plans were collected. The plans consisted of an article on watersheds, questions about the article (seatwork), a one-day lab on purifying water, and one day given to the team teacher for a double period. There was no suggested or implied connection between the unit and the activities that the substitute did.

Mary was back Thursday, the eleventh day of the unit. Students picked up their neuron note journals, which were graded by the student intern, took their seats and waited for Mary. Mary was at the overhead writing a question for a fast write. Mary had been gone for three days and was not prepared for class. It took nine minutes for Mary to develop the writing assignment. Students were to write about what they learned over the past three days. Students started to write, when Mary tried to give more directions,

I want to know how things went for you and how things went for your group. I know that there was a lab . . . activity that you did while I was gone, and (hesitation) . . . maybe it worked out, maybe it didn't, whatever happened . . .back here and (hesitation) . . . Is there anything I should knowwww? (drags out the last word for emphasis). It's your chance, too . . . well, like some (never finished this thought). It's an opportunity (hesitates over talking students) let me know things about . . . that . . . In the same breath, after telling some students to be quiet, Mary resumed her explanation, "AllIllIsssooo [carries on word for emphasis], and this is probably the most important part, next to the thinking about the past few days is . . . what did you learn? You were taught . . . learning about purifying water and making it drinkable."

After students had been writing for several minutes, Mary asked students what they had learned about purifying water. Some students did not stop writing, never-the-less, Mary continued with the questions, "What have you learned about purifying water? What did the cotton do? Did it change color? What is the function of the carbon?" One student was asked to answer per question. They did so quickly, with one-word answers, and that ended the questioning. The teacher then moved to the next phase of the day's lesson.

The second part of the class was preparation for another field trip, the next day. This field trip had more logistics involved. The teacher had to arrange for buses, collect \$2.00 per student to cover costs, collect student permission slips or inform parents, and coordinate with the team teacher. The teacher also had to contend with students who were not going on the field trip because of their involvement in sports. These students received excused absences; hence, the teacher had to arrange ways the students could make up the work. It involved twelve boys and girls and became an added plan requirement for the teacher. The two classes would be divided between the student intern

taking one class to a clean creek and Mary taking a group to a highly impacted [polluted] creek. They would later switch, such that each group would experience both creeks for comparison. The weather had to be contended with, and Mary informed the class, "It is doubtful that it is going to be any better than today, so please bring your boots, hats and gloves. You will not be allowed to go without a coat."

The third part of the day's plan was Mary informing students that they would be receiving a mid-term progress report. The teacher passed out the progress reports and gave the students an opportunity to look at them and then reviewed how their grades were calculated. Students guickly learned how many zeros, or missing papers, affected their averages. They were given an opportunity to look for papers not turned in, not graded or missing, with a chance now to make them up before the progress report went home. Mary explained how the "Neuron notes," a multi-part assignment that always followed a mini-lecture, and were scored as a quiz or test. Completing the neuron notes required students to a homework portion that involved drawing a picture, explaining what they had learned, and writing questions over the activity. With this explanation, Mary ended the lesson by giving the class the last twenty-four minutes of "study hall" for make-up work. The teacher impressed upon the students the need for a good working environment, "There needs to be absolute quiet."

The second class of day eleven had everything waiting for them. There were no delays and no passive periods. The teacher greeted students with instructions to pick up their

journals and begin their fast writes. As the writing went on, the teacher quietly approached students for their permission slips. This was done as a separate step in the first class and cost Mary ten or more minutes. Students without permission slips were directed to call their parents on the class phone and let the teacher hear that they had permission to go on the trip. Mary stopped the writing with the announcement that she wanted to explain the proper dress for the field trip. The explanation was several minutes shorter than the first period. She did not ramble on about the proper dress or pose any threats should they dress inappropriately, as she did in the first class. This led to a second announcement that she wanted to hear what they had written, "What did you learn about water purification?" In the first class, students continued writing during the questioning phase. This time, the teacher made sure all students were paying attention. She asked fewer questions and called on fewer students for responses. Two minutes were allotted, and Mary moved on to the progress reports and the problem of missing work. While passing out the progress reports, Mary explained, "I want you to go back to your seat and look at it [progress reports] and start planning out how you are going about finishing your assignments." Mary informed the researcher that this group had a very low-grade average.

The twelfth day for both classes, was the two-hour field trip. Logistics proved to be a problem more time was needed to prepare before leaving. After a half-hour to prepare to leave and fifteen minutes to get to the first creek, half of the class time had been used up before students started taking their measurements and viewing the creek. Mary had to adjust the assignment to one creek. She and her intern went back to the second creek and took all the measurements so students had data they could compare.

The thirteenth day, there was no science class. Both science classes participated in a local forum with the team teacher leading it. Various local candidates for legislature were coming to present their views. Mary discussed with students how to ask the candidates questions after their presentations. The forum or details of asking questions did not appear in her lesson plan, suggesting an activity that just happen and was not pre-planned.

The fourteenth day, Mary returned to her normal routine. Arriving early, the researcher hoped to engage Mary in conversation about the field trip. Mary was sitting at the computer, eating lunch and typing. She greeted the researcher with, "I'm scrambling again . . . have you ever done this? The researcher nodded and Mary exclaimed, "Oh, I wish I had more content!" Mary explained more of her plans, particularly her attempt to connect the present unit to the new unit coming up. She said, "I have to do more with these materials to connect and add information to bring it [the unit] to proper closure." Mary asked if the researcher had ever left planning right up to the last moment. The researcher's response was non-committal. Mary started class by dividing it into two parts. She asked students to fast

write, asking them what they noticed about the creek they went to Friday and having students read what they had written. Mary's comments were restricted to questions about what students saw, such as, "You saw what? What color were they, Red, okay." After questioning just two students, Mary moved on to showing students how to read graphs.

The data about the two creeks was used. Mary found that she had to spend extra time explaining the various abbreviations used on the graphs. More time was used when Mary was sidetracked to discuss the merits of testing up or down stream. Mary assigned students to write a comparison of the two creeks in terms of the various test results they found. Students had difficulty with this assignment because they could not determine or understand in what ways measurements make a difference. Students did not understand the significance of a measurement of 8 ppm to 11 ppm, except that one was larger and one was smaller. Judging by the questions students continued to ask, the troubles did not go away with the teacher's responses. The class ended on this note.

The in-service day (the fifteenth day into the unit) was not observed. Initially, permission had been received from the principal, but later some opposition turned up to my presence at the meetings. There were no science in-service programs. In a later conversation, Mary explained that the in-service was a "catch-up day" with each teacher working in his or her room.

The next full day of teaching was the following Monday, the sixteenth day of the unit. Mary had flipped her math and science classes in order to accommodate a consultant, who was observing her math classes as part of a newly adopted math program. Mary was unable to tell the researcher the classes were switched and no observations were made.

The seventeenth day of the unit began with a brief comment on what had happened the day before. Essentially, Mary reported, "The class worked on their temperature neuron notes and notebook." Her lesson plan for the day said the same thing. The second class followed the same plan. Both classes wrote in their journals. The next part of the class featured a guest who represented a group who monitored clean watersheds. The visitor played a short video and talked about a model of the local watershed. There was no time for questions, and the classed ended.

The second class, Mary adjusted the watershed part. She divided the second class into three groups, with one group view the model of the watershed and the other groups working on the neuron note assignment until it was their turn to view the model. Mary did not view the model, but worked with students as they wrote in their journals. The class ended with a short "fast write" about the model and students' received their school pictures, which ended any further work. In conversation later, Mary informed the researcher that she had to postpone the "New" unit by a week and added time to finish the first unit.

The eighteenth day of the unit, Mary greeted students from the overhead, ready with another neuron note session. This consisted of copying notes given by Mary at the overhead. Mary continued by playfully warning students that they would take lots of notes. "You will write to wear your little fingers down to stubs," she told them. The students took extensive notes. The notes were copied verbatim from a prepared overhead. Sometimes, Mary would attempt to add information to the content being explained on the overhead and she would occasionally have content errors. Students would also ask questions that she could not answer, "That is a good question, but I don't know," she would answer. A another response was, "I need to look that up." At the end of the class, Mary vented her exasperation, holding her head, saying, "Eh! . . . I will do this in another way . . . next year.

The nineteenth and twentieth days were shortened days and the last days of the units. The class began with Mary upset over a missing calculator from the math class. Her feelings carried over through lunch and the science class and rather than prepare for science or lunch, she used the time look for the calculator. One could tell on arriving that her mood was dark and uninviting for conversation. The class began, and overheads were not prepared. A few girls in the corner were not paying attention, again. Mary's plans began to adjust. She started to write the overheads as students waited. She asked a few questions as she wrote and accepted the answers. Several minutes of explaining followed with

lecture and answering student questions. She seemed better with this presentation and moved on by giving an assignment, a poster and story that synthesized the unit. The students would work in groups for the period and into the next day.

The second class began on time with the overhead transparency ready Mary was able to explain the new assignment immediately without having the students wait. The explanations and questions went much smoother. The only drawback was providing students with poster paper too soon. The students played with these in a distracting manner without progressing much with the assignment. Mary recognized this, made a few pointed comments and students settled down and started the task. Toward the end of the period, Mary came by the researcher and uttered her frustration.

Oh, well, another day. I'm just not happy these last two weeks with the way things have gone. It's not the way I know I can teach. I'll be happy when I start River Cutters (next new unit). Something different maybe, yes different. Lesson plans are in the book, lots of prepping but the plans are inside.

Observations of New Unit

Mary's second unit, River Cutters, was a self-contained module developed by GEMS. To Mary, the unit was new. She was aware of the unit, but had not taught it before. She liked the selection, because she felt the unit made good connections to the previous unit. The River Cutters unit was heavily based on hands-on lab activities and required daily, extensive prepping. The preparation component, and its development, required the purchase of materials that represented out-of-pocket expenses for the teacher, and Mary enlisted her husband to buy the much-needed diatomaceous earth that was not found locally. He hauled 100 pounds in an over-weighted suitcase from California. The River Cutters unit objectives basically dealt with modeling the characteristics of a river's movement, in this case, through a diatomaceous earth river system.

The first day of the new unit, Mary greeted the students of both classes with statements of starting a new unit, River Cutters. After naming the unit, Mary proclaimed, "I have not done this unit before. It's a unit I have not taught and so I am new at this." Neither class responded in any way to the declaration. Their expressions did not change. No one took notes and there were no comments or questions. Students appeared to wait to hear what else she had to say. Her plan book did not have any entries referencing the teaching of River Cutters. It did have an entry about taking the temperature of the fish egg tank. The fish eggs represented a class project. For some time, the class had been keeping a temperature record of the tank as the fish eggs matured. The idea was that after a certain number of degree-days, eggs would develop into the eye stage and then to the fry stage.

In both classes, after the opening comments, Mary started a discussion about local landforms. In the first class only, she used a two-minute fast write. At first students were hesitant to read what they wrote. Either they

didn't have an answer or were unwilling to participate. In this case, Mary provided a landform example that caused students to call out some other local landforms. Mary accepted the call outs as okay answers and ended the discussion and moved to the next topic. She did not make any connection between the landforms questions and the new unit. Mary began by explaining the difficulty in developing the unit. She had difficulty finding diatomaceous earth a vital material needed to develop the river model and stream tables.

Her plans did not show the large amount of time needed in the preparation of the equipment and materials for the first activity. In the first class, Mary had to describe the equipment students would use to develop a river model. She used a literal description for the equipment, calling the stream tables, tubs; water timers, water bottles; and river models, rivers, when they really represented a system that modeled the development of rivers over time. This introduction to the equipment and materials should have served as a pre-lab for the investigation planned for the next day. This appeared to illustrate that Mary had some understanding problems with the content and methods of teaching. In the first class, the explanation and demonstration did not go well. Equipment did not work, water sources did not provide water, and water would not move. The stream tables were not elevated enough to develop gravity flow for the rivers. In the second class, she said, "I'm going to show you how this all works. I am going to tell you ... last ... last period, it was disaster." And she

said, "Part of it is, ah . . . I'm not sure what is going on, but hoping that we have this sorted out, now." Mary proceeded to meticulously explain the equipment and operation of the tubs, but ran out of time.

Day Two began without a conversation as Mary was very busy getting the equipment ready for the class. The class began on time. First, students recorded the temperature of the fish tank and then the teacher engaged students in a review of yesterday's directions. Students were placed into new of groups four. In both classes, Mary went over the directions to make the first "run" of the river model. The direction detail was greater in the fist class, but was mixed with extra explanations of unrelated information, interruption by office announcements on the PA system, and the discipline of students who were not paying attention.

Second class directions were fewer, more concise and clearer than the first class. During the activity, the students played with the materials and equipment, they had to take time to learn about their group, familiarize themselves with materials and decide what to do. The second class group was new also, but adapted quickly and worked well. They operated as a team, completing the activities with most students participating.

Mary's directions did not clearly define group expectations and acceptable behavior. During the activity Mary moved among the groups. She reminded students of lab procedures, methods and techniques, but asked few questions about what was happening. Students were directed to draw

what they saw, but they had little knowledge with which to name the developing landforms on the model. This was how the book developed the concepts on characteristics of running water-rivers and Mary was following the book.

The second day was a school highway litter clean-up day, so there was no science class.

The third day, students entered the room and Mary had everything ready. She started with a daily activity to measure the water temperature of the Salmon egg tank and record it into their journals. Mary would find a student to do the measurement each day. After the measurement, Mary commented, "Good, we are making good progress to 200." The 200 figure is the number of accumulated temperature units when Salmon eggs should have mature enough to make the transition to the eye stage and become fry. Throughout the unit, Mary had continued to reference this number and comment on the egg development and to keep it in the students' mind. Science-wise there was little connection between the maturation of Salmon eggs the Rivers Unit; however, the students were slowly beginning to demonstrate an interest in seeing the end results. The class continued and the period was divided into two reading a poem and listening to a song about rivers and followed by a short discussion. A fast write completed the day.

Mary had students read the poem aloud in both classes. After one or two lines, Mary asked students what the author meant. The lines were highly metaphorical, and students had difficulty rising to that level of thinking. Mary tried to

explain, but shortly she ran out of things to say and ended with,

I think what . . . he had in mind . . . is the Babylon people . . . was the first big civilization with ah . . . all sorts of . . . ah . . . they were the first people to plow field and . . .

Mary's comments often ended with generalizations like, "The Congo . . .ah . . . specialize in different, different ah . . . areas of work and things." In the second class, Mary admitted her explanations were interpretations, she saying, "I don't know, I'm just throwing that interpretation in there."

After the poem about rivers, a taped folk song about rivers was played. Mary encouraged students to sing along. Some students tried, but were looking around to see who was watching and eventually no one was singing. There was no discussion about the song. The class continued and Mary directed students to take out their journals and drawings of the river they had done the day before. Mary asked the class, "What features did you see?" It was quiet. No one ventured an answered. Mary rephrased the question. Still no answer. Finally, Mary called a student by name, and weakly, he whispered, "Channel." Mary commented, "Okay," that ended the discussion. Mary announcement that she was going to pass out a description of various river features, and students were to take this and see what features they could identify on their drawings. In the second class, students were more responsive to her questions. They were able to name several river features to which, Mary commented. She repeated

student answers and often rephrased or filled-in the answer to make it more correct.

Mary had made an extra river model set up for students who were absent or were unable to complete the activity. She told the students,

If you didn't get a drawing of your river, you can draw one of the rivers up here, and . . . ah . . . also . . . you need to use the materials that I just gave you the resources to . . . to identify land features and label.

Once each student had a river system drawn and labeled, Mary and the class discussed the meaning of the different river features. During the time when students were drawing the river features, Mary came back to the researcher's position to talk. She wanted an impression of her teaching of the first and second classes. The researcher asked her what she thought. Mary replied, "Well, I think I favor the second class. I know them better." The second class was Mary's homeroom class, and she was their advisor. Later, Mary said she knew that the second class got better teaching, so on two occasions she reversed the classes, in the new unit, the first became the second class.

Mary asked students more questions and gave further explanations about the river model, but none of the questions or explanations appeared in her lesson plans. Mary's questions seem to develop as a result of the activity at hand, with further questions after students submitted a response/answer. "Did you see any features listed here?" A student answered, "Alluvial." Mary responded with, "Yes, so

what's an alluvial fan?" Mary added the term fan to the student's answer. Not all answers were correct, but she continued when a student said, "A U-shaped valley," and Mary rephrased to, " . . . a V-shaped valley for river valleys shaped by water. In both classes, Mary began to ask students to explain their answer and taking fewer one-word answers. When a student answered, "Tributary," Mary, affirmed the answer, with, "Oh, yes, that could be a feature. What is a tributary?"

The fourth and fifth day, there were opportunities for Conversation with Mary before the classes started. It was going to be a double period day (first class for two periods and second class tomorrow for two periods). The researcher helped Mary place the stream tables, position the materials, and fill the water timers (dyed blue to simulated water). It was a good atmosphere in which to talk about the activities and teaching. Mary prepared her overheads and directions for the next activity, which came directly from the teacher's copy of the text. No other lesson plans were developed. During these activities the talk was general and random: however, Mary again raised the point about her teaching, "As you can see, I'm doing my usual scrambling." She never seemed to have enough time, but there was no evident time user, at least not in the classroom.

Mary had opened the class with a review of the previous day's activities and attempted to draw connections between the features of their river models and slides of various local river features. Mary asked questions and explained
each slide. This required Mary to acknowledge the student responses and provide deeper explanations. Her explanations varied in completeness and content. In one example, Mary explained,

This is a point bar. That's where the water slows down and silt and sand drops out . . . (hesitation) because it slows down . . . this Is an example of deposition.

The second part of the period was a new investigation requiring students to run an activity that forms a river. Mary also reviewed clean-up procedures and urged students to follow her directions. In the interview following the unit, Mary said, "I began to use reviews a lot. I felt we needed them." This also meant that Mary was positioning herself more as the giver of information. During the investigation Mary noticed two stream tables with no one working at them. She asked the class if anyone was absent, to account for the open tables. There was no answer, and the vacant workstations remain empty, despite large groups working at the other stations, she chose not to move groups around.

During the activity, Mary demonstrate her tolerance levels for student behavior was lowering, proponent of Assertive Discipline placed her third student name on the board within fifteen minutes. This was the detention step. The number of names was three times the number she had placed there before.

Back to the activity, the river, which the students made, represented a system undergoing a glacial change. Students were modeling the development of U-shape river valleys, typical of glacial action. This activity took only a few minutes and left groups standing around for conversation or play, as a result Mary spent much time managing the group's behavior.

During the activity, Mary swung by the researcher's station and said,

I rehearse this stuff soon many times in my mind and just . . . ohhh, this is a really hard lesson to pull off with kids. I think it is almost impossible.

Later, in conversation, Mary questioned the worth of the activity as conducted, "There was so . . . much pandemonium. I don't think they were learning." In the interview following the unit on this topic, Mary said, "I'm not used to pandemonium or noise. I spent days planning this . . . the steps, imagining the layout, and what to say and do and still had break-downs."

During this activity, student ability and skills varied. Some groups worked well together and others did not. The equipment proved to need constant care. The drip timers were too small to complete a run and required filling every five minutes. This created problems because students were unable to replicate drip rate, but wen unnoticed. The activity wanted students to become more familiar with the passing of time from the Ice age to the present. Students were to add markers along the river model to represent time passed as the river cut deeper into the earth's surface.

Mary continued her thinking out loud, suggesting making changes, "I will make smaller groups and cut down on students moving around." Mary had made it a point earlier to let students look at each other's rivers. With that, Mary turned and begin to walked away, she was still talking and kind of questioning herself and the book, wondering if it was worth it. After a pause, she said, "It is."

The second class's fourth and fifth day's started with changes and additions from the first class. The class began with slides of local river features and a discussion, as did the first class, except Mary eliminated the extra explanations, which was often filled with inconsistencies and errors. She kept her explanations to the descriptions of the slides.

After the slides, the introduction of the next investigation was possible. A connection had been made on how river valleys were shaped. The development of a U-shaped river valley was demonstrated at the teacher's station. The groups, now pairs, created a U-shape valley using the river model they had made earlier. Mary was excited about the activity. She recognized that it was working. A student was heard saying, "What is the teacher excited about?" and another student answered, ". . . something in Science?"

Mary made changes in the second class. She exchanged the shorter stream tables for longer ones. This allowed the creation of longer river systems with more defined landforms. Larger ice cubes were used to carve the river valley, which created very dramatic lateral and terminal moraines. Students were more involved, working diligently. As the class progressed; however, one group near the teacher's desk accidentally knocked off a file of papers. The contents went everywhere. Mary threw up her hands in exasperation, in a what else could go wrong, gesture. Mary's student intern rose to the occasion, waved her off, picked up the papers, and put everything away as it was before, Mary could then carry on as if everything was okay.

The sixth and seventh days were double periods, one day for each class. Measurements of the fish tank were continued. There were now nine stream tables, which prompted Mary to change the group size and reassign students. The first and second class lesson plans were identical and implemented in the same way. Mary began by talking about the possible presence of toxic waste dumps adjacent to rivers and Students were to simulate toxic waste dumps (water dams. soluble dye markers) around their river model, and build a dam some place down stream, and observe the outcome of the moving water. Mary was convinced that the dam's spillway was down, rather than up. The student teacher caught the error and corrected Mary, but this required verification by the textbook before Mary would accept the change. Later, Mary let it be known that she had a difficulty modifying activities that were recommended by the book she was using. She couldn't and wouldn't make changes.

The eighth day, the researcher arrived and discovered that the student teacher would be teaching both classes. Mary had an unexpected meeting with the math consultant about the math program the district was adopting. The intern mentioned that he knew only an shour before the class, so he

had nothing prepared. There was no substitute. The researcher stayed for both class sessions, not to observe the student teacher but to collect Mary's lesson plans and to see how the plans were developed. A special education teacher did showed up before class to help two students with their science assignments. Mary came by to tell the researcher that she was leaving for the rest of the day and would see him tomorrow. Mary's lesson plan was brief, consisting of one activity, which was carried out by the intern, with one change. Longer trays modeled a river that had little slope and because of this, the water of the river did not flow well. The intern had students raised the tray by adding a 2 X 4 at one end to increase the slope. Later, in conversation, Mary felt he should not have done that. Asked to explain more, she said, "I have difficulty modifying the directions in the texts." The investigation presented difficulties because students did not know how to take a core sample, taken with a straw (sticking the straw into the soil) and extracting a plug. If the plug was colored, it signified toxic waste had reach this area. The lesson plan did not contain any directions for this method; consequently, the students ended up, literally, digging their samples.

The ninth day began with Mary's announcement that she was going to collect their journals. She wanted them handed in by groups. Mary explained, "I want the journals to come in by group, because it is easier to collect, and only one person from a group has to bring them up." Mary continued the class by asking questions about meandering rivers.

Interestingly, Mary had asked a similar question earlier, and she had received about the same answers. A student said, "They curve around." Mary accepted this answer with, "Okay, they have curves," but had change the answer in the paraphrase. Her lesson plans did not list the questions or picking up the journals.

In the second class, Mary's instruction was changing and different. In the first class, she had shown the students pictures of two river systems and had asked them to look for differences. In the second class, she said, frame the question such that students knew more about the picture, "Here are two pictures . . . a picture of the Green River, and you can see the valley here. It's very steep . . . and there is a lot of erosion. See, sedimentary layers of sediment have been exposed." Then she asked students to look for differences. The different approach allowed the second class to complete the task easily.

The idea behind Mary's this strategy in both classes was to help students learn how to ask testable questions, in this case, involving the river model. The final activity consisted of students designing an investigation. She set them to writing questions that would lead them to more information about the rivers. One student read his question. Interestingly, it ventured an assumption and speculated about the hardness and softness of the area surrounding the two rivers. Mary acknowledged the student's question with, "Okay. Okay, any other ideas?" There was no response. Mary was at the overhead with several examples of possible testable questions and experiments. In both classes, students were asked if the example was a testable question. Later, a river was run based on the question, "What are the effects of slope on the formation of river features?" The activity proceeded with Mary and the intern circulating among the groups to help develop testable questions. In conversation after class, Mary expressed her day as, "Well, that was better." She also mentioned that she had to adjust the schedule to fit the three-day Thanksgiving week, "... So Monday, students would plan their investigation, do the work on Tuesday and report their results on Wednesday." Mary reflected that having the extra stream tables was good, "I like the extra set-ups. I wonder how I can have more."

The tenth day in both classes followed the same plan; however, there were instructional differences. The first class came in the room, and Mary was sitting at her computer entering grades. This went on for several minutes. When she finished, she informed them, "You had a little kick back time and now . . . extra credit in science." Classes began with students taking and recording the Salmon egg water temperature of the fish tank. The second class did not receive any kick back time or extra credit. Mary's explanation for this was the first class needed to raise their grades. In the second class, in place of the extra credit, there was a carefully worded monologue by the teacher about systematic observation, control experiments and variables. Then in both classes, Mary had a handout, which included everything she had said but divided the entire

process into stages. The first stage was the planning stage where they were now. In the first class, Mary reversed the lesson by first passing out the handout and then going over the paper, line by line and stage by stage. In both classes, Mary carefully talked about inquiry, systematic observation and variables. These terms were defined in the handout, but not in the class. The handout had four examples of possible investigations to see if students could pick out the various terms Mary was talking about. In both classes, students were able to pick out the terms from the examples. Mary had groups meet and brainstorm ideas for questions they could investigate. They could bounce the questions off her or the intern. The groups were informed that they had the remaining part of the period (25 minutes) to work. Mary and the teacher intern moved around to various groups to see how they were progressing. Each was heard to offer suggestions on various aspects of the river that could be investigated. Students were to work on and complete their experiments the next day.

The eleventh day was experiment day for both classes. Teacher and intern both served as gophers, assisting students in finding the materials and equipment needed to conduct their investigations. Some groups also needed further consultation with the teacher or intern to develop testable questions. After twenty minutes, all groups were working on something.

The twelfth day included reports of results of the investigations by both classes. Mary informed each class

that written reports would be due after the holidays. Only three groups in the first class and four in the second class reported. Other groups said they were not ready to report. As it turned out, Mary commented that the reports were not very good, "The written reports were really bad, but I don't think that they . . .these kids had the experience they would really need to develop a good systematic study."

Post-observation Interview

Mary's interview occurred four weeks after the River Cutters, or new unit. It took place in her classroom at the end of the day. Mary was asked about her impressions of the two units, Water and River Cutters. Mary said,

The water projects . . . I don't think I will do another water . . . per say. I came out of that feeling really frustrated. I think part of the Reason why'. . . cause (I was) using someone else's unit and they had a lot of other people to help with it. . . I don't know . . . I think I would rather look how land was shaped. . . River Cutters . . . It was an awful lot of work . . .

When asked about her planning for the units, Mary said, "There is planning all over the place." What kind of planning was that? "Well, just getting the diatomaceous earth . . . my husband had to go south . . . pick that up for me." On getting ready to start River Cutters, she said, "One day . . . it took four hours, Bill and I to get ready." You had biologists come in. "I had to call and call . . . probably three different times before I hit somebody . . . who could do it." Mary also disclosed that she had to start calling two weeks ahead. What else did you have to do?

There is so much . . . you know. I can tell they are not getting this concept. How am I going to tweak things to bring that idea out . . (Laughs). It's wake up at 2 AM and your planning you know, you are thinking about how to pull things off, how to prioritize. I am not being specific at all. It's hard though . . . it's not unconscious, and it's so fleeting.

Mary disclosed that she was involved with a program "<u>Barriers</u> to Learning." This was the program that caused her to miss three days from school. Mary was asked about the program,

We are going to have to tweak the model a bit ... to use it. To serve ... basic needs of the kids. The kids that are hungry ... are not ready to learn.

What aspects of the program are useful in the classroom?

I think just having the mindset. It's easy to say . . . oh, well . . . this child has such a messed up life . . . it's beyond my scope, but I can do the very best I can in my classroom and not just count him off . . . nothing will come of that . . . You somehow just got to keep trying.

Summary

This summary combines the results of the observations of the "Regular" and the "New" units. It is based on the questions for the study, namely the planning and implementation of planning and its relationship to Mary's growth as a teacher. Mary's classrooms consisted of seventh and eighth grade students in combined classes with an average attendance of 28 students and a high of 32.

The observations of the Regular and New units of instruction revealed several aspects to Mary's planning and implementation of planning (teaching). First, Mary's lesson plans was not written out. In Mary's words, "My lesson plans . . . I must confess that they are in no coherent order." On one occasion, while correcting homework questions, a student suggested that Mary read the questions and give the answers. Mary said, "Well . . . because . . . because I don't have them written down." Mary's lesson plans could have been more detailed for her substitutes, but even those plans consisted only of the basic materials and a schedule of activities. The substitute could only go through the activities, much the way the students did, without involvement with the material and no connections made to the units in progress. On returning, Mary addressed the activities of the three days but made no reference to connection with the unit.

Mary plans, though not formally written, consisted of randomly made notes and lists that she prepared. The notes consisted of single words, topics, phrases, or lines that said to do something, find something, or talk to someone. For both units, Mary utilized and depended on the unit planning of the locally developed teacher outline for the Water unit, and the teachers' copy for River Cutters. These units had objectives, teaching suggestions and materials lists, as well as activities and readings. Mary never mentioned teaching to the objectives. Mary selected activities, but not necessarily with objectives in mind. The materials available were greater than the time allotted for

the units. The entire water unit was over nine weeks long. Mary's selected the monitoring section. The same was true for the River Cutters unit where she omit several investigations.

Mary had routines, which she relied on each day. These were writing activities, "Fast Writes and Neuron Notes." Usually, Mary would follow a fast write with students reading what they wrote, which was not discussed or responded to. She accepted what students read and moved on to the next question or topic. In the Regular Unit, these activities averaged fifteen minutes per day, and ten minutes per day in the New Unit. The difference in the New Unit was because the readings were often eliminated.

On occasion, Mary would have a discussion, which could evolve into straight lecture. Her lectures served as the main form of transferring information to students for both units. The lecture filled the gap between the labs and the models river features they were developing. On two occasions, Mary promised the students, "You will write to wear your little fingers down to stubs."

The Regular Unit was built around three field trips in which stream-monitoring data would be analyzed. Mary spent much time reviewing the procedures for the different water tests and providing directions for participating in field trips. Mary tried to enlist the aid of students to plan the field trip, "I need your help to plan this and see what we can do in two hours." Mary had no experience organizing a field trip. Students in the first class could not remember

any of the tests and could not agree on which ones they wanted to do. Mary ended up telling students about the tests and repeating the directions. The second class was better, but Mary did not give them any chance to build the activity themselves, and provided all the information herself. She said, "All this activity . . . going to the field, is professional development. I haven't done this before."

Mary's preparation for the second field trip required more organization. Both classes were going, but to different locations, then switching. This way, each class would have collected data from two streams, one clean and one polluted. Mary arranged for buses, collected students' money, organized study periods for students who were not going on the trip, provided make-up work, made sure students dressed appropriately for rainy weather, and made sure students knew which test they were responsible for and how to do it. In the second class, Mary was more efficient. She paid extra attention to directions about the trip. Students were greeted with a "Fast Write," previously written during the first class. Students did not have to wait and they started to write within seconds of sitting down. Mary eliminated reading answers and went to covering field trip needs and finished by discussing grading and grades.

Mary's biology background did not include the concepts or experiences taught in either unit. The Water Unit was based heavily on measurement of water quality and Mary had to learn how to perform each test in order to teach it.

Mary made no reference to aligning the units to the Alaska or National Science Standards, though a copy of the Alaska State Science Standards was posted on the back wall of her room. Mary's planning was devoted to selecting the activities students would complete in the units. The three field trips were necessary in order to monitor the streams and compare them with each other and previous years. The River Cutters unit was based on many investigations. She had mentioned she was trying to select investigations that related to the Water Unit; however, in the unit, some ongoing activities students completed were not related to The Water Unit or River Cutters, such as the water purifying lab and fish egg temperature data.

On occasion, Mary's planning showed last minute arrangements. After her return from the conference. Mary started the class not prepared. The "Fast Write" question was not ready. She made it up as the class waited. When Mary was ready, she let it be known that she was giving the class "kick back time," another way of saying, "I need some catch up time." After the fast write, Mary changed working groups, right in the middle of the unit. She couldn't explain except that it was half way through the grading period and is what she did. The second part of the class had students read a poem and listen to a song about rivers. Mary tried to lead a discussion about the meanings of lines in the The students' knowledge for the metaphor-laden lines poem. was limited and Mary's explanations were short, fragmented

and random. This was also the first and only time that Mary tried to connect activities outside of science.

Mary's planning included students working in groups for field trips and investigations during River Cutters unit and the final assessment of the first unit. Students were assign to identify a mystery stream based on data collected earlier. In the New unit, student groups had to develop a question to investigate. A report and posters were prepared.

Mary voiced awareness that her teaching was different between the two classes, but her reasons were not content or teaching. She treated the second class differently because, "Well, I think I favor the second class. I know them better." Later in the unit, she switched first and second periods a couple of times.

Mary's questioning techniques hinged on developing questions to fit the context. The questioning portion of her class did not appear to be planned. She had no pre-written questions. The sessions were from two to 10 minutes and averaged three questions. Her questions were simple and required and received one-word answers. Sometimes she would repeat the answer. Mary would add information or fill-in and answer to make it more complete. If the student said, "D.O.," Mary would define, "Dissolved oxygen is . . . " If the student said, "Alluvial," Mary said, "Alluvial fan." Only a few times during questioning did Mary ask a student who gave a single-word answer to explain. A student said, "Tributary," and Mary said, "Tributary. What is a tributary?" Mary created questions as the lesson developed.

No questions were recorded in her lesson planbook, notes or lists. River Cutters teacher's book did have some questions available, but Mary did not use them.

Mary relied heavily on the River Cutters book. She was more familiar with the Regular Unit material, despite not having taught it before. It had been an on-going project in the school for several years. Mary used the River Cutters book extensively, following the directions, "I have difficulty modifying the directions in the texts." Mary's statement confirms her limited subject matter knowledge. Had she been able to alter more than she did, students would have had less difficulty following directions and developing their rivers.

Case Study

Pam

Description of Teacher and Classroom

Pam's education background consisted of a Bachelor's degree in Natural Resources Management and a Master's degree in Environmental Education. Pam had taught eight years, seven at this school and one year in Bush Alaska. Her class assignment was one sixth grade, two seventh grade and two eighth grade science classes. The two seventh grade classes, periods one and two, were observed. A fifteen-minute homeroom preceded the first class. The first class had sixteen students, was made up of 10% Alaska native students and six girls. The second class had nineteen students, with seven girls and 12% Alaska native.

Pam's classroom came close to approximating a science classroom. Students sat at laboratory-like, chem-resistant tables, with storage below for equipment and books. Each desk had an electrical outlet. She had the desks set up in a U-shape with the teacher located in the middle. Two large sinks sat along the wall. The room measured thirty by twenty-five feet and every bit of space was used for a wide array of science materials and equipment. The walls and cabinets were full, and in the back were two large tables the length of the room, with shelves, more materials and equipment.

Pam was the only middle level science teacher. She was very active in teacher groups and with her middle grade students. Her assigned extra duty was the advisor/homeroom for the seventh grade class that occurred just before her first science class. Pam took the assignment seriously. Homeroom required Pam meeting with students each morning to informed them of school and special events that might interest them. For example, she wondered if any would be interested in entering the Harry Potter writing contest. The contest had initially forgotten Alaska students and were now rescinding their position and letting Alaska students enter. Pam's room was open to students, morning, and noon and after school. Students were always present. The classroom had a telephone, so she was also accessible to parents and community.

Observations of Regular Unit

During the initial conversation to secure Pam's acceptance to participate in the study, Pam had talked about herself and teaching. She disclosed, "Getting started this year is different, I didn't take a month to get ready for school." Pam said she allowed herself two weeks to get ready because, "I need to keep my head straight, relax and start rested. I took a long trip to Australia. I was excited about that." As we were talking in her classroom, three students entered the room minutes apart. To each, Pam greeted them warmly and was happy to see them. "How can I help you, John?" She asked. To another, she said, "Did you go all the way home, then come back. Wow! Nice going." Later she told John, "Thanks for coming in John." Pam raised other topics. She mentioned that one of the things she wanted to do this year was to re-work the science curriculum. She didn't go into any detail. As the conversation wound down, Pam mention again that she needed more time, "I need more time . . . need R and R and getting enough sleep to do it." This was the second day of the school year.

The "regular" unit (any content organized in a time frame) was about Wetlands, in general and specifically about the immediate area. The unit started with both classes going on a field trip. When the researcher arrived, Pam greeted him with "I thought you were coming tomorrow," while at the same look, as if to say, "What are you here for?" She had not mentioned the field trip in our meeting the week before, just that the unit was starting. The field trip would include tramping around boggy wetlands, and of course, the researcher was not dressed for that kind of outing. Referring to the timing of the observation, Pam said, "I'm not sure field trips are good. No lesson plans to keep. The kids are doing independent projects and I'm not teaching." When asked what she meant, Pam said, "I have much to do with classes and NEA . . . take too long to tell. I have to go." With that, she turned and hurried out the door. A minute or two later, she returned and wrote a note to herself on the blackboard and hurried on to the next task. In passing, she raised a new topic in reference to becoming a teacher, "I didn't think I would be teaching, but I had to do something. I wasn't going anyplace in Park Management." There was no chance to ask any further questions.

The second day, the researcher arrived early, hoping to find Pam. Pam was in conference with her principal. The principal had a standing requirement for all teachers (K-8) to show him their weekly lesson plans. The checking took only a few minutes and then they talked for several more. The researcher waited and made a note to talk to the principal. The principal said later, on checking the lesson plans, "I check for goals and planning for everyday." Pam said, "It didn't make any difference. It was something she did anyway."

Pam's lesson plan book was written as an outline in a chronological order. An entry would be homework, stamp, discuss and collect. There were no details; there were notes and lists of things needing to be done before the class started. Pam was asked about the checking. She said she didn't mind, "It's something I do anyway." She added, "Science doesn't have state standards yet, otherwise . . . they have to write standards . . . Language Arts."

Once the principal left, Pam was a whirlwind of activity. She had only a few minutes before her first class arrived. Something needed to be cleaned. Something else needed to be put away. She dropped her pencil and left it there. She didn't finish her clean up. She was busy as the first students began to arrive, but she moved forward to say "Hello." A student came in and introduced her to a new student. The student addressed Pam by running her first and last named together. She was not Ms. Clark. She was PamClark. This started because Pam had several students with the same first names in both classes. It was easier to run the names together to distinguish between students. For example, MichaelTucker and MichaelBaker were their class names. Pam caught the new student by surprise when she extended her hand to shake his. He took her hand hesitantly. Throughout the period, Pam remembered the new student, making sure he got the papers, loaning him a highliter and checking that he was following along.

Pam was talking as she handed students their papers. Pam announced, "Conversations are over, focus on me." Discussion began with Pam asking about the field trip last Friday. "Where did we go?" A student was called upon, answered, and the teacher found and highlighted the area on her map. Students followed suit on their maps. This process continued until twelve locations had been found on the map. Many students participated in locating the areas, either answering or affirming someone else's answer. Pam liked what she heard and said "Okay guys, (you) did very well on . . . on this one."

A second paper was handed out. Pam informed the class that this was for quiet reading and highliting the four W's, who, what, where, and when. After reading, a discussion was initiated. She asked the students, "Who is the who in this article?"

After the discussion, Pam informed the class that John went to the moose hunting meeting last night, and she told the class that she had asked John to tell them about the meeting. The class listened as the student outlined the difficulty in shooting a legal moose. The teacher framed the first and second questions, "What is best, shooting an animal without fifty inch spread (rack) or 3-brow tines? What should they do?" Several students spoke up, as many had experiences of a parent to share or knew someone who had shot a moose that proved to be less than fifty inches or fewer than three brow tines. The talk went on for several minutes. Pam injected timely questions to keep the discussion flowing. For example, she reminded them that the reg. (regulation) said fifty inches, not forty-nine and a half inches, which caused one hunter to pay a large fine. What should they do . . . let him go?

When the class ended, Pam reminded students as they were leaving, "You have a test on Thursday, and bring back your permission slips ... Mr. Holmes needs them."

The second day for the second class followed the first class in time and plans except the moose discussion was left out. Pam asked the same questions for both the homework and the reading. For a couple of questions, she had to supply the answer. She did, and she added several minutes of more information. Students were not taking notes, and not many were paying attention.

When the class ended, there was a five-minute break between classes. The researcher was getting ready to leave when Pam came over and said, "Well, it will be interesting to see how I am doing with different classes." The researcher had mentioned that she was welcome to see the field notes and the videotapes when they were done, to which Pam responded, "Well, I don't have time for that."

The third day, a brief conversation with Pam was possible. Students were in the room. Pam was at the computer recording grades of the homework papers she wanted to return the same day. A question on homework went unheard or unanswered, but then Pam commented, "I do the reading assignment also for extra credit, as well . . . it is the only way to get them to read." Pam mentioned that she came in everyday at 7:00 AM.. She was required to be in school by 8:00 A.M. and her first class was at 8:35 AM. As students arrived, Pam greeted them, "How is it going?" and then announced a 'Chat Time,' so I can get a few thing done." The chat time was free time to talk to their neighbor, but not across the room. Meanwhile, Pam was recording grades from the home papers. She stopped after twelve minutes, with one class recorded and most of the homeroom class over.

Pam announced a fall quarter project. Students had one home project per quarter. She explained several aspects of the activity and sent home a handout that explained the project and the parents' role. The second class did not review aspects of the project. They were told to look at the handout carefully. A five-percent bonus was offered to the first class for those who turned in the project early, but the bonus was not mentioned to the second class.

A lab (the only one in either unit) exercise had students finding out how much water could be "drunk" by sphagnum moss. In this activity, Pam used the common terms drank, drunk and soaked up for the word absorbed. The teacher questioned "How will we do this?" One student suggested, weighing the moss. No other students commented. Pam didn't say any more, but began to pass out directions and materials. Students started the lab, but the class ended before they were finished, leaving Pam with clean up. In the second class, Pam skipped passing back the homework papers. She didn't get them recorded. Pam apologized and said to the students that if they wanted them that day to come by after school, and she would have them done.

Pam started the second activity, calling the class to attention, "Listen up, 100%!" She explained the quarter project, then started the moss lab by asking students to

predict how much water the moss would drink. There were no attempts to answer and Pam did not call on any student. Pam passed students the lab directions and started the lab. The second class was able to complete the lab assignment.

The fourth day, the researcher arrived to find Pam making copies for the lab. Without any preceding question, Pam volunteered a comment, saying, "Doing labs takes so much time." Class started right after her statement. She had been too busy to greet students upon their arrival. She was busy finding materials and equipment to complete the lab that had been started the day before. The Class settled in and the first ten minutes were devoted to "Stamping" the homework. Stamping was a process where Pam checked each student's homework and stamped it. The stamp was not a grade, but a quick skim to see that the assignment was done. During the stamping, Pam spoke to each student about the assignment, writing out his or her answers, or suggesting coming in for help. She also talked to those who had not yet completed the homework. Students could get half credit if they went out in the hall and completed it. Pam said that stamping allowed her to see who has done the homework, how well, and if they had written out their answers in complete sentences. The middle school had a policy to improve writing skills in all classes. Pam was trying to live up to that policy. During the stamping time, students would quietly talking with their neighbors. They could not leave their seats or talk across the room. The stamped papers were collected later for full grading.

A discussion about the homework started, but the telephone rang and interrupted Pam. She talked for three minutes while the students waited. Starting again, the question/answer section of the homework consisted of Pam reading the questions and asking students to answer. She usually cued students to read their answers. Pam was sidetracked, using the time to talk about bears. The bear topic ended and Pam jumped to yet another topic. This time, she talked about doing quality work, "When you walk through that door I expect quality." The statement started and ended the topic of quality work and she returned to the questions. Pam called on a student to explain "indigenous" the student answered and Pam corrected the student, "Answer in a complete sentence, please." Often, Pam would add information to the answer, more than the question required. To the student's explanation of indigenous, "They are Natives. "There are indigenous people on every continent. The indigenous people of Australia are Aborigines and they are famous for their powers of . . . " In the second class, students had difficulty pronouncing "indigenous." Pam described, "Some people thought it meant igneous, some thought it meant ingenious, but it's indigenous. Everyone say this out loud." Pam, too, would ask questions that served her to answer. The questions were usually beyond the scope of the assignment, or asked students to think. On these occasions, Pam's wait time was very short and she would provide the answer.

During one of the last homework questions about plants sensing sound, Pam asked, "If plants listen to singers, would

they grow better? What if you have recordings that somebody actually made from a trained [voice] and another voice was a shower-singing voice?" Students did not attempt to answer this question. Pam continued to talk, saying, "There is a good science fair project for ya."

The homework papers and reading were cleared away, and Pam moved to the unfinished lab that was started the day before. She asked, "We are going to see how Sphagnum mosses . . . how much they had to drink." She went through the activity, step by step. In the middle of the directions, Pam had to ask students to focus, "Shhhhhh . . . let's focus. P--H-O-K-I-S." A student asked, "Is that the way to spell focus?" Pam answered, "I'm teasing." The lab proceeded with students reporting how much water the moss drank. They added these values to a data table Pam drew on the blackboard. Students were to copy the table, but had difficulties with the abbreviations that she used. Pam had to explain the various abbreviations used in the table. Though the word absorbed was not used when she talked about the moss, it was used on the table and abbreviated abs. Pam told students to put how much the moss drank under abs, and did not explain further, or make a distinction between the terms used in the lab. Later, she used the term "soaked-up' for absorbed.

As the first class was leaving, the teacher reminded them that they have a test tomorrow.

The second class followed the general plan of the first class. Differences were in Pam's talk with the class during

the stamping and questions. This class received a strong reminder on writing complete sentences. Pam emphasized,

I'm very clear about complete sentences. I'm very clear about writing complete sentences. If you don't write complete sentences for more than one (homework) I'm not stamping your paper . . ."

Pam then raised the specter of the eighth grade exit test. "What are the three ... the big three they test you on?" A student said, "math," and Pam corrected, "No. No. Math, Writing and Reading. That means I have to have high standards for writing in my classroom." But, Pam distanced herself from the writing process, by saying, "Though my class is not writing. You know it's . . . If you don't know how, then work on it." Then, in the next breath, Pam said, "Raise your hand if you know what is a noun. Do you think you can recognize a noun?" Most students raised their hands. Pam finished stamping homework papers and began to go over the answers, "All right, answer in complete sentences. How many species of carnivorous plants are there in the wild? One student replied 600. Pam responded "Have to say it in a whole sentence." The student answered again, "There are 600 carnivorous plants in the wild." A student answered the next question, "What happens to an insect if it touches a carnivorous plant?" "They die." Pam wanted students to describe the process, "No you can't just say, 'they die,' I want the gory details." Students responded and Pam summarized dramatically, ". . . they sort of make this flood

and it washes them [insects] right into . . . bottom, digestive . . .slurp"

The lab, started the day before, resumed, though, this class was able to complete most of the lab the day before. They finished taking the final measurements and comparisons. There was a 500-ml range between answers. Pam noticed the difference, "What do you think of that?" The question received no answers, and Pam did not pursue it any further.

The fifth day started with the researcher chatting with Pam before the students arrived. Pam was wondering about the field notes and the tapes. The researcher assured her that the data was for the researcher's eyes only. Further talk centered upon Pam's previous work with park management and her sense of fairness. She felt that Alaska Park Management consisted of the "fair haired, white-boy club," and women didn't get a fair shake.

The classes were divided into small groups for a short study period of approximately seven minutes. The test followed and many, students in both classes finished within fifteen to twenty minutes. Students then followed a routine of reading while the other students completed the test.

The sixth day marked the end of the unit. Pam's plan book said, "grading test," but before the first class started, four eighth grade girls greeted Pam. They were concerned about grading the test in class. They did not want the tests corrected in class. Pam asked, "How come?" One student replied, "Some of us don't want others to know what we got." Pam responded, affirming that this was a great time saver for her and ended the conversation with "okay, we will see."

Pam opened the first class with comments on scoring points, "It is your points earned, not lost. She did not mention scoring to the second class. Pam continued, "You are not starting with a score and losing points." With that the grading began. Pam randomly distributed the tests. She would read a question and call a student to answer. Pam served as the final authority and would respond to a student's answer with an, "Okay, right, right on, I'll buy that, and two points," if correct. If incorrect she would say, "No, no go, nope, zero for that, not good enough and no points." Students hearing the accepted answer would mark the points down; however, if the answer they had was slightly different, they asked the teacher to judge, and Pam would accept, not accept or give part credit, one point. Early, in the first class, there was a question no one could answer. Pam had to explain the full answer, "So . . . have something about a low spot and decomposition, otherwise, no points."

Students would read whatever was written. Usually, the answers were written as single words. There was no reference made to writing in full sentences. Sometimes, Pam would have the student reading a single word answer identify the owner of that test and have him/her explain the meaning. If they could explain the answer, they would receive full credit for the question.

In both classes, it was quite common for Pam to repeat the answer for all to hear and to designate the point value

for that answer. If the answer was not fully correct, she would call another student to read what he or she had. The process was repeated until a correct answer was found. Usually, though, Pam would provide the answer after one or two students were unsuccessful. At these times, and there were several opportunities in each class, Pam's explanation exceeded the question, with her explanation going beyond the simple answer to that question. In talking about wetlands absorbing water, she explained,

If they are water logged . . . that's what my mom used to say. She gets so mad. I grew up in the suburbs . . . the paperboy rode a motorcycle right across the wet lawn. . . Do you think you could see tracks for a while?

Another time, referring to wetlands providing a cleaning process for water, she explained,

It's great to have a wetland next door to you, next door to a salmon stream. But they need to spawn where the water is flowing and has oxygen. The eggs need lots of oxygen, and 'stone cold' water is a good thing.

Often during these explanations, Pam paused, and what began as an explanation in one direction became an explanation in another direction. Referring to salmon, Pam started, "The eggs are going . . . " Then she would pause and turn the statement into a question, "Where do salmon eggs need to be laid?" Other times, her pause led to a story or example of the concept. In the second class, after a student response to a question, Pam said, "So, what?" There was a moment passing, and she said, "I don't mean to say that, I don't agree with that . . . then what . . . ?"

In both classes when the grading was completed, scores were tallied and tests were returned to the owners to review. Correcting the tests took the full period. Later, Pam collected the tests to check the grading and the addition.

Observations of New Unit

The first day of the new unit, Science in Sports, began the first Monday after the regular unit. This unit had never been taught before. Pam collected materials from a variety of sources, including magazines, journals, and newspapers. In addition, feature articles of individual star athletes were available. Essentially, the science concepts involved in performing an Olympic sport were the learning goals. The summer Olympics were in progress, with the opening ceremonies starting the day before. Pam had recorded the ceremonies.

Pam began both classes in the same way. She started by explaining that each of them would select a sport and report on it. On grading, she said,

I'm not going to give you a quiz or test on all of this. You are going to have one of those terms, I call it Alternative Assessment. I have another way I will judge, whether you understand how sports uses science . . . You are going to make a poster of it (sport). And everyday you will write in your new learning log. You can start a new page. Today, the Olympics began with the opening ceremonies, and I planned that you would see parts of it. The ceremonies were four hours long, and Pam had not edited the tape for the sections she wanted the class to watch. This caused her to search for the different spots for viewing. During this time, students were to write in their journals, but most sat, played, or talked and generally, shifted their attention. Students were assigned to write in their learning logs about the "Olympic Torch" and "Fire Breathers." As the class watched the ceremonies, Pam commented about the Australian people, Pangea, continental drift, and big feet. She had visited Australia the past summer. Students asked questions during the fast forward times, and the conversation would turn to another topic.

The second day, the researcher arrived early for a possible conversation. The room was closed, and Pam was The teacher had forgotten that there was a faculty qone. meeting scheduled for that morning. After the meeting, Pam found the researcher ready to go, but Pam was not happy about losing her morning prep time. She was visibly agitated. She smiled weakly. She began lamenting about the lost time, that copies had not been run off, the machine had jammed and something she was looking for remained lost. Students who arrived early were exposed to her upset personality, by shortness with them, no smiles and no tolerance. A student asked, "We going to see the TV again?" He moved his chair to be in front of the TV set, which was left, in position for class viewing from the day before. Pam saw the movement and acknowledged the question, "You should not be assuming and should be in your seat," she said curtly. That ended the

conversation with the student. The researcher offered to be of help, as Pam looked for something on a very cluttered table. She said, ". . . I don't have time to delegate." With that, she looked away and continued to search on the table. As she did so, Pam said, "I don't . . . you should come back for the second period. I don't want the pressure . . . " An entering student came by and said he had his homework, and Pam said, "Good! I expect nothing less." The researcher, heeding Pam's feelings, went to the faculty room until the second period. Pam's parting words raised the point of time, "I somehow forget how much time it takes to do this. Oh! Well, it's better than lecturing about Newton's laws of Physics."

The second class began with an apology to the researcher and a mumbled comment about no time. Pam then asked for assistance, "Here is something you can do. "I need 55 copies of each." During an interchange between her and the students, Pam said, with regard to students getting their report cards, "Some of you need to turn over a new leaf. Some of you need to turn over a whole tree." Pam was feeling better, free from her agitation. Pam's attempt at humor went over the heads of the students. No one laughed, just head scratching and blank stares, questioning stares. A (brave) student asked, "What's the meaning of 'turning over a new leaf?'" Pam asked the class and received more silence. She told them. "Turn over a new, change behavior, get off to a fresh start." She continued to explain,

Turn over a new leaf means you have been dabblin' and fiddlin' and seeing how

little you can get away with. Now is the time to stop doing that and see how good you can be. That's the ticket.

The discussion continued with Pam not working from notes or lists of questions; nevertheless, she would form and ask a question and wait for an answer. Students were unable to answer any of the questions. This went on for a couple of questions until Pam began to add hints to the question. What does cross training mean?" became, "How is cross training involved in different sports?" The questions continued. Students were doing better, because most had read the article from which the questions came. Pam also continued to use metaphors within her comments and explanation. In last four questions, she used, "Really feeling buff, blow off steam, clear the deck, freak out, mind over matter," and in one sentence, she said, "Just for kicks and stick our necks out, use your noggin, and you gas out your opponents." With the last example, Pam sidetracked to a topic that was raised at the morning staff meeting,

We talked about the problem of kids not taking showers after PE. I don't want you to have 'bacteria forms' all over your body the rest of the day.

Pam finished up with a couple more questions and moved to setting up paper for taking notes. The students were directed to fold notebook paper into four columns and then fold the last column once more for two sections. The four columns and two sections were then labeled. Each column became a category to describe an aspect of a sporting event.

This became the basis for the information that the posters required and Pam used examples to show this to students. Swimming was the first sport to be described. Students would watch a video of the event that Pam had record the evening before. Pam would tell the students what to write under each category. Pam read the information from card notes that she had prepared. For example, the first column was technology and the class wrote that the swimmers wore suits that were coated with Teflon. A student asked, "What does that mean?" Pam replied quickly, "The stuff that lets you fry an egg in a pan." Students accepted Pam's declaration. The other categories followed this format until the period ended.

The third day, Pam acknowledged that yesterday was upsetting because of losing her prep time. She greeted the researcher with a big smile, and said, "Sorry. When I lose my prep time, it sends me into a tizzy." Though her behavior was short with students, as well, Pam did not say anything to them. Pam also revealed that she had started to plan for this unit this summer and shared a newspaper of all the Olympic events. She said she got the idea to show "... that physics is a topic in Olympic human sports activities."

Pam reviewed the homework with a discussion. The first topic was about athletes and asthma. As the discussion progressed, Pam described what it meant to be asthmatic. This led to her telling a story involving a child with asthma, "I saw this little kid; this little kid had it (asthma). He was trying so hard to breathe that he was sucking in . . . he almost . . . there was a big indention where his stomach should be." Her voice faded. Students leaned closer to hear. Pam said something, but it was not clear. Then she raised her voice and all the students were now listening,

There was panic feeling. Your face is grey, cause you are not getting enough oxygen. It's scary. So, he's not able to get fresh air cause he can't get the old air out.

Pam used stories like this, and despite the content, the attention was greater than at any other time when she was talking.

Discussion then turned to swimming and the physics involved. The first topic for review was density. As Pam was talking, she moved away from the security of her table and chair searching through the cupboards and shelves. She found what she wanted and returned to the center of the room with a container of water and a glass of vegetable oil. Pam held up the water and asked, "Which is more dense, water or oil?" The students predicted water. Pam mixed the two liquids and the oil floated on the water. Indeed, the water is denser than oil.

Pam's planning then turned to a description of the poster requirements and the scoring rubric. The period ended with Pam recording a sport for each student.

The second class began with teacher checking and stamping homework. Part way through the checking, Pam accused three students of copying and refused to stamp their work, "No stamp for you three." The students denied that they were copying. After stamping, each question of the
homework was reviewed. Pam covered the variety of topics much the same as the first class. She retold the asthma story and used the readymade density demo. Pam showed the bottle to the class explaining that the oil was the top layer and water was the bottom. She then asked which liquid was the denser. They got it! Pam told a new story of floating rocks-Pumice.

Pam talked more in the second class. She often asked a question, but answered it herself after a short wait period with no immediate student response. Other times, she would read the question and name a student to answer, all in the same sentence. If the student was unable to answer, Pam either answered the question or called on a student who had raised a hand.

During Pam's talks, she would pause. "What part of your body comes up if you push your chest down?" --Pause. She answered, "Your butt comes up." --Pause "Be sure you write a complete sentence." Pam then explained the poster, as she had done in the first class, and selected a sport for their poster.

The fourth day was routine. On arriving, Pam greeted the researcher with a smile and a "Good morning." Pam reviewed the next few days for the researcher and explained that she would be gone the next day. Her request to attend a science conference was approved. There would be a substitute and the assignment would be to watch Olympic events to record in their Olympic journals, and to complete homework reading and questions. Her planbook listed one simple entry: movie

and read. Pam also revealed that the mid-term grades for both classes were not very good. In an attempt to improve the grades, she would give them an opportunity to work. Pam provided each student report card with a complete breakdown of all the work they had or had not done. Later, she let it be known they could improve their scores by finishing the unfinished work, staying current and doing well.

The class began with the mid-term report cards. Pam explained how they could improve their grades and secured their promise they would try. The lesson followed. Students first took notes and discussed the physical characteristics some sports require. Pam then planned three demo/activities to go along with Newton's three laws. The activities were highly active and students in the first class "Really got into them," but not from a science standpoint. The activities were the same in both classes; however, Pam omitted the first demo in the second class, only to later add it back in, "I wasn't going to do this, but you are doing okay with these." This demo involved students bumping a wadded piece of paper, simulating a "volleyball." The first class did everything except bump; they tossed it, threw it at one another, and smashed it. The second class really tried to bump and put the object into motion. The other activities were checking for the center of gravity, and coins striking each other to demonstrate action-reaction.

A fire drill broke up the sequence of the next activities in the first class. After the delay, the class returned and took notes about swimming, rowing and filling in

their table to describe the sport. Pam provided all the information from her card notes. The second class followed the same lesson plan.

The fifth day was a sub day. Pam's plans were brief. There was no observation.

The sixth day was Monday and Pam had returned from her conference. The morning meeting brought a quick smile, a warm greeting and information about the conference, on the science of Arctic environments and the native people who live there. Pam was more open to give information about the unit. She informed the researcher that she had decided to do a short version of the Olympic unit with the sixth grade class. Everything will be the same except, "My expectations will be less than seventh grade." This meant she was now teaching some form of the unit to all her classes, the eighth grade as well, and had reduced her basic prep to one class.

The first class started with talk about grades and student behavior. In regard to grades, Pam announced she was available for help after school. She was upset with students who were, "Ripping off classmates when I am trying to teach." Pam was referring to the talking behavior and inattention when she was talking, "You are eroding my teaching time." In the second class, though, she didn't say anything to them about talking. She did discipline a student for talking. He was moved to a new seat and told to stop talking. The boy continued the behavior and Pam said, "Be quiet . . . talking is stealing my teaching time." Pam's activities were examples of the requirements for the poster. Pam used the viewing of different Olympic events to discuss the three categories: skills/strengths, physics principles, and technology. The class watched an event and Pam described what should be written down. The example modeled what they needed to report for their sport. For example, on single sculls, students wrote about the oars under technology. Pam added, (Oars) . . . were hollow and made of light weight carbon fibers. Carbon is charcoal briquette. You are carbon, . . . ah . . . actually mostly water." The latter statements, Pam added. They may have been copied down, as well.

The seventh day moved quickly for both classes. In the first class, lessons were broken up by the presence of a nurse's aide who was taking small groups of students for TB test and eye/ear screenings. The routines were modified. Pam stamped the homework, reviewed questions by reading the questions and providing most of the answers. Since her wait time was exceptionally short, students were not able to respond quickly, and it appeared that after a while, they refused to respond at all and let the teacher do the answers. Pam was willing to accommodate. As a result, it was a quick review of the homework. What usually took twenty to thirty minutes was cut to five minutes. Pam delegated a student to pick up the papers, which she hadn't done before. The extra time gained by the quick homework review was used to watch different Olympic events. Pam described them according to categories on the chart, from information on her note cards.

The pre-recorded Olympic events were on several tapes, which required Pam to run the VCR (no remote) and to rewind or fast forward, as needed. She did it this way in both classes, using time to locate the events she wanted the classes to watch. During the locating process, students occupied themselves with talk. They watched gymnastics, women's Floor-X competition, and then discussed the human physics associated with the various moves.

The eighth day started with the researcher talking to Pam before class. The researcher inquired about the inservice happening in a couple of days. Pam explained that she was meeting with a reading group for part of the day. The group was reading the book was <u>Mosaic of Thought</u> (Keene & Zimmerman, 1997). Pam said, "We [the group] selected the book." Asked if I could attend, Pam said, "Should be fine; you know everyone there."

Both classes followed the lesson plan for the day. Homework reading and questions were stamped quickly. Pam did not spend a lot of time checking. There were no comments about writing, except that one student's paper was proclaimed exceptional, "You are just a star." Later, it was discovered that the student had answered a question in two ways, both good answers.

The remaining forty minutes was for computer time. Pam had arranged time for students to use the computer room. The observations continued there. Clearly, half of the students were unable to use the computer well enough to find information. Pam had to help, and she was constantly on the

move, up and down the rows of computers. It was the computer teacher's break period, and he was not available. Many students were trying to print pictures of a performer in the sport they selected. To this, Pam said they could take one picture from her resources. Later, as computer time was running out and several students did not have a picture, Pam said, "Put your name on the board, and I will run one off for you."

The ninth day of the unit represented a change in the unit plan.

Today, we will not be watching track and field and taking notes, or describing the skills, physics and technology. Yesterday, I saw you had a fair amount of work to on your poster. I originally planned to do track/Field today, but we really need to get ready for your poster.

The remainder of the period allowed students to start their posters. Students had forty-five minutes allotted to get paper, cut it to the appropriate size, and find more pictures. Pam's help was needed. Many students could not use a meter stick, and the measurements were in inches. Some students, particularly in the first class, needed monitoring so that they didn't turn the meter sticks into swords or paddles. Pam was very busy helping students prepare their materials and have them ready to take with them. This was the student's Friday, with school the next day due to teacher in-service, so the weekend and Monday were the last days to make posters. Two seventh graders in the first class had completed their posters and were left to their own resources. Pam had no provision for early finishers.

The tenth day into the unit was a teacher in-service. No observation of the classroom was made; however, the inservice was attended by the researcher, who sat in on a reading group of middle school and elementary teachers.

The eleventh day was the final workday in the unit. Students in both classes spent the entire period putting the final touches to their posters. Pam assisted students, and offering help where needed. She got after one or two who were off task. Pam's plan for the day was to help. She did.

Post-observation Interview

Pam's interview took place in her classroom about six weeks after the unit. It was after school and students were preparing an entry for the door-decorating contest. They were in another part of the room.

The interview began by asking Pam, "What about Middle schools?" Pam began talking about grouping and "looping," (a teacher assigned to the same group of students for two or more years), sixth grade going into the middle school, and block schedules. Pam was excited about ninety-minute classes which another school had,

... so I feel a little bit robbed. I want what they have ... I want to put something together like that and have two hours. That is my biggest jealousy, is not enough time to screen a lab, set up a lab, do a lab, collaborate on a lab, modify it, wrap it UP and clean it UP. (She said UP with emphasis). Time also entered into her responses about the Unit, "Yes, I wish that I had more time planning it. I never, always know exactly what to expect." On the Olympic videos she recorded and time, she said,

I wish I had more time to have my videos . . . really structured, or like some people do, put them on the internet . . . computer, and push a button and have exactly what you want.

Pam had used valuable minutes searching for video excerpts she wanted students to watch. During these periods of rewinding or fast forwarding, student's socialized and waited. Then they were asked to start again, taking notes for the categories.

Pam pointed out some influences on her planning and teaching. Pam said, "I keep my booklet of Alaska Science Standards (several generalized statements) beside my lesson plan book. It reminds me that I teach skills, as much as content, both thinking and lab skills." Pam had not previously mentioned Standards or the AAAS Benchmarks in terms of her unit planning, "Lately, I have been reviewing the AAAS benchmarks . . . ," she said.

On the New unit, Pam said, "I'm happy with the content but not necessarily happy with the delivery or the organization." Pam felt she would repeat the unit at some time, "I just need to structure it better, structure it tighter . . . " She continued, explaining other things she could have done,

When I was talking {to her class} about this unit . . . talk about drug testing and drugs and how it relates to health and how they actually do drug testing. I wish I had put a little more of that but takes more time to integrate it . . .

Pam did not keep a journal; however, she wrote notes to herself in her daybook about things to do, students, what someone said that was funny and ideas. Pam was asked if she wrote anything about teaching. Pam said, "Journalizing, it could be more . . . you spend so much frantic time cooling off. So you don't really have time to reflect."

Pam was asked about her use of metaphors, analogies and a variety of phrases. She said, "I think it's my nature. It's kind of painting an image." On understanding what she is saying, Pam said, "I know some of them (metaphors and analogies) go over the kid's head and I am . . . realizing that they have little experience with words and are not big readers . . . but I think it helps."

Summary

This summary combines the results of the observations of the Regular and New units. It is based on the questions for the study, namely the planning and implementation of planning and their relationship to Pam's growth as a teacher. The classrooms observed were two seventh grade science classes, scheduled for the first two periods in the morning. The class sizes were sixteen and nineteen.

The observations of Pam's two units of instruction revealed that her planning and implementation of planning contained aspects of teacher growth. Pam wished for a textbook, but didn't have one. This made it necessary for

her to develop units of instruction. She would have developed the units, regardless of the study's observation of a new unit. Pam developed lesson plans for both units that were outlined by the week, and had daily details which were lists and note. Pam did not have long-term plans, just a few units at a time. She taught one set of plans for both seventh grade classes. The principal checked each teacher's lesson plans for the week. The principal said he was checking for lesson plans and goals. Pam said, "I don't mind. It's something I do anyway." The lesson plans did not contain any details beyond listing the activities, homework, reading and lecture. Some of the details in Pam's planning were notes or lists, and usually, referred to things to do, or have ready, for today and tomorrow. Neither the lesson plans nor notes and lists contained any details as to the implementation of planning or teaching. Pam's plans and notes contained no comments about students who needed help or contact. There were no prepared questions she wanted to talk about over the homework or current unit in progress. These came from the materials in use and were developed as the activity unfolded.

Watching Pam, one gets caught up seeing a person constantly on the move, talking, and literally bouncing from place to place. Listening, you hear a rapid talking person, very spontaneous in using her voice: high, low, up and down, holding words and/or speaking in accents. Because of this, it is easy to miss the fact that Pam teaches a very structured and routine program.

Pam starts each morning at 7 AM, in what she considers her prep time. Her first class was at 8:35 AM. Any deviation from her pattern of prepping in the morning was a setback in the schedule she had for herself. On one occasion in the New unit, Pam didn't remember a morning staff meeting, and consequently, lost most of her prep time. She was not happy and visibly agitated. She was lamenting the lost time, "I have nothing run off." Pam used her early morning prep to make copies and set up for the day's activities. She had nothing ready for her classes of the day. When students began to arrive, her mood did not improve and she was curt with them. A student had moved his chair in anticipation of watching a video, as they had been doing. Pam saw the movement. Her voice, as well as her words, portrayed her agitation, "You should not be assuming and should be in your seat!" The researcher offered to help, but got a look, and "I don't have time to delegate" response, followed by, "I don't . . . you should come back for the second period. I don't want the pressure . . . " The researcher left and came back the second period. Later, the next day, Pam apologized and conceded that she needed help getting some papers copied.

Pam's routines contained weekly lessons that included homework four days a week, Monday through Thursday. The homework sequence each day lasted an average of twenty or more minutes, or 40% of each day. Each morning students would get out their homework and Pam would stamp the student's work. During the stamping of student papers, Pam would talk with and see students and their papers. What happens, what is said depends on what the students say and show her for stamping. Pam took this time, not only to look at the work (not correcting), but also to visit and talk with each student. Sometimes she saw something that made her address the whole class, and other times only the student in front of her, perhaps inviting him to come in for extra help after school.

The correction of the homework also had a routine. Pam would read the question and call a student to answer. A student would read the answer they had and Pam would affirm its correctness with an "Okay, yup, I'll buy that," or some other phrase. If the answer were incorrect, she would call an another student until a correct answer was read. Incorrect answers received a, "Nope, no, not right, or no points." Once in a while, Pam would ask what something meant and students would explain or not explain and say, "I don't know, or that is what I wrote." All questions were answered in this way, and then the papers would be collected. During the answering by the students, Pam often commented on the answer and provided more information than the question or student wanted. This prolonged the activity.

The length of the routine was due to her follow-up explanations, comments, or anecdotes. An example of Pam's explanation was seen when she spoke about student grades, "Some of you need to turn over new leaf, and some of you need to turn over the whole tree." A student asked her what "Turning over a new leaf" meant. Pam said, "Turn over a new,

change behavior, get off to a fresh start." She paused and then said, "Turn over new leaf means you have been dabblin' and fiddlin' and seeing how little you can get away with. Now is the time to stop doing that and see how good you can be. That's the ticket." Some of her comments had nothing to do with the original homework question. Often the talk after a question was an extension of the answer, although the information given was not needed. To the question, "Explain indigenous," The student answered, "They are natives." То this, Pam said, "Okay. There are indigenous people on every continent. The indigenous people of Australia are Aborigines and they are famous for their powers of " In the second class, Pam asked the same question, but this time anticipated that students would have difficulty pronouncing indigenous. "Some people thought it meant igneous, some thought it meant ingenious, but it's INDIGENOUS (with emphasis). Everyone say this out loud." As it turned out, indigenous was never defined in the second class.

After the homework section, students often would do an activity that involved reading and questions, a lab, a demo (lab and demo once in the New Unit). They took notes from Pam which were placed in their science journals. In the Olympic Unit, students filled in a table/chart from, with notes, about segments of Olympic sport events (several times in the New unit). The table/chart information also came from Pam.

Pam planned both units in the absence of a textbook. The Wetlands Unit was one week long, and designed to describe twelve local wetland areas, each very different. The New Unit, Sports and Olympics, was based on the physics of human movement and technology in sports and used the Olympic athletes as examples. Pam said she started thinking about planning the New unit during the summer.

Pam's science content was very broad. She was an environmental conservation major and had a twenty-year career in park management in Alaska. Her background was well suited for teaching the Wetlands Unit. The New unit, though, had technology, human physiology, and physics requirements. Her resources were a variety of Olympic publications. Throughout the unit, Pam was seen consulting note cards. Her notes included such newly learned information as the coating used on swimsuits to make gliding through water easier (Teflon) and the material used for the oars of single skulls (carbon fibers). Pam said she was comfortable with the content for both units, "I'm happy with the content, but not necessarily happy with the delivery or the organization." She was referring to the Olympics Unit. In her interview, she said, "I wish that I had more time planning it."

Pam always seemed to be running late, looking for something, or commenting that she didn't have enough time. She used a "Chat time" to finish recording some grades so she could pass back student papers. Students sat and talked for 12 minutes. Her planning did not include the periods when she explained a little longer, or talked to a student, or looked for something and it wasn't found. Such things really ate up her time.

Pam's planning did not include everything she taught. In her interview, Pam mentioned other things kids should learn about besides content. Standards remind me that I teach skills as much as content, and understanding the whole child must be considered while still focusing on what we are tying to accomplish academically." Pam would shake students' hands when they had done well, cue students to possible science fair topics not assigned until several months later, recognize students' outside activities: how many points they scored, how fast they swam the butterfly. She would let them know it's important to take a shower after PE. She would tell them they get no credit for cheating. Pam demanded respect between students and expected quality in their work and behavior. She aimed to "Teach the whole child."

CHAPTER V

Discussion and Implications

Introduction

Einstein (1938), who alluded to the merits of being able to think and reflect, inspired this exploratory study. Einstein's reflection applies well to teachers and students alike, as does another thought espoused by Holt (1974), who said, "We should try to turn out people who love learning so much and learn so well that they will be able to learn whatever needs to be learned." Combine these thoughts and we have the components for teacher growth and development during teaching.

This study was mandated by the need to understand middle level science teachers' growth as they plan and teach. The study was directed by two questions: 1) How does a middle level science teacher plan and implement instruction? 2) What are the impacts of new subject matter and/or a new instructional approach on middle level science teachers' planning and implementation of instruction?

Practitioners know that teaching is not simple. It is difficult to think, or imagine, that educating students and trying to make a difference could be so complicated. The simple recognition of its complexity offers no solution to the task of making teaching easier, better or more effective.

Sparks (1997) suggested three conditions for professional development (growth). Growth should be results-

driven, standards-based, and embedded in teachers' daily work. It is held that these conditions may be observed at the individual level.

In this study, three middle school science teachers' planning and teaching of a "Regular" Unit and a "New" Unit of instruction were observed and analyzed in terms of teacher experiences. The teachers' classrooms were observed, and the teachers were encouraged to talk about their teaching and growth. This context placed the teacher in a dynamic situation where planning and teaching was on display daily, thus the suggestion that experiences are illustrative of minute spurts of teacher growth and development. Each day of teaching impacts the next day's experiences, which result in yet more experiences. As teachers plan and teach, they are accumulating experience days that are examined for relationships between the planning and teaching. It is possible that the experience days can have a positive outcome or direction, because they can promote growth (Dewey, 1938) in an individual. A negative outcome (direction) suggests that a teacher's action was inappropriate, or insufficient, and resulted in no growth.

Following a discussion of the above topics, the implications of what these results have on middle school science teachers, education, in-service education and professional development are examined, along with the limitations of the study. Finally, recommendations for future research are made.

Teacher's Preparation to Plan

Teachers plan lessons and implement them in the classroom every day, but planning and implementation of planning (teaching) are more than just an act of writing something down. Shavelson (1976) suggested that planning included the most important decisions teachers make, since teaching is based upon planning. The implication is that planning is a dynamic act that requires the skills and thoughtful thinking of the teacher. Too often, the dynamics of planning by teachers are reduced to selecting activities. As such, teachers do not have to invest a lot of time or expend much energy.

The process of planning units of instruction by each of the three teachers in the study followed different paths. At best, it was an imperfect process. The paths taken by each teacher were related to her own developmental track in becoming a teacher, to the situation and context of her classroom and community, to past experiences, to content knowledge and subject matter knowledge, and to her willingness to risk observation. Three teachers, Judy, Mary and Pam, will be discussed.

Judy was an English, History, and Math teacher assigned to teach middle level science. Judy had been misassigned (Ashton & Webb, 1996) in this school district before and had accepted the role cast upon her. Judy didn't question the assignment. It made sense to her, as well as to the administration, that she teach science. After all, she taught all the other middle school subjects. The decision was not based on her science content knowledge, which was lacking, but rather on the fact that she was a middle school teacher. The sad fact of misassignment, universally, is that rarely do administrators do anything to assist a teacher in her new teaching situation (Ashton & Webb, 1986). To Judy, it meant she was left to find her own sources of help to teach the seventh and eighth grade science units she had selected. To her advantage, the administration left her alone and her autonomy was secure to proceed as she desired. Her attitude suggested she would do the best she could, both in learning and teaching.

Another teacher, Mary, taught a class of thirty-two students in a model middle school in an urban setting. Her math major and science minor made her a good candidate for team teaching seventh and eighth grade combination classes. The school was unique, an education model, and it operated on the philosophy of a school within a school. The science teachers in the four "Houses" designed the term curriculum. With the curriculum set, Mary had only to develop a scope and sequence for the two units and select activities. Mary was familiar with both units, but she had not taught either unit. The subject matter was new, thus, like Judy, Mary was in a situation that would require new efforts. It should be noted that developing and teaching new units was a normal situation for each teacher and not manufactured for the study. In all cases, selection of units was made before the teachers knew about or had agreed to be in the study.

Pam, the third teacher in the study, was in a different situation than the other teachers discussed. She taught sixth through eighth grade science in a rural community. Pam, a science major, evolved into teaching after a twentyyear career in Park Management. Pam's first unit was about Wetlands and was developed a few years earlier and had been taught previously. The second new unit was about Olympic sports, the physiology and physics. There were no textbooks for the unit. The new unit was not designed for the research study. Planning the new unit started during the summer, before the study had begun. Pam had connected the unit to a trip to Australia, which had occurred just prior to the start of the Summer Olympics. She was still collecting materials at the start of the school year and through the observed wetlands unit, which was taught the first two weeks of school. The new Olympic unit followed the Wetlands unit.

Planning Instructional Units

The concept of planning was viewed differently by each teacher. None of the teachers was committed to spending much time or energy on writing formal lesson plans; however, this didn't mean they didn't plan. There is more to planning than writing down lessons and activities. Pam made the classic plan outline in her lesson plan book, partly to satisfy the school district requirement to document everything that was taught to students. The district was concerned that students who could not pass the high school state exit test might sue. The principal checked the plans weekly. Pam said she didn't

mind, as she would have written her plans out anyway. The other two teachers, and Mary in particular, wrote no plans. Mary used only the teaching guide for the unit. Judy's lesson plans were brief sketches of what she would do each day for the unit. She made lists of things to do, which she prepared the night or weekend before.

Planning Produces Tensions in Teaching

The teachers in this study did not think or consider that their quick, simple planning practices (Costa & Garmston, 1994; Shavelson, 1976) were part of the teaching process. Minute omissions of the teachers' perceptions, student needs and thinking were the foundation for developing tension(s) in the implementation phase of planning (teaching). Tension, according to Webster (1973), is a general stress or condition brought on by some force. In this study, no teacher expressed that she was aware of tensions (Fenwick, 2001; Hayes, 2002; Newman, 1998) or chronic uncertainty (Cohen, 1988; Lortie, 1975) over teaching. Rather, all were aware of what they saw or had perceptions of a need to do, to get, to have, to say or to find something. Tension, as defined, includes anxieties, stresses, and forces.

In teaching, there were several areas in which tension could develop. Tension development began with what did or did not occur in teacher planning and moved through to the first, "Good Morning, Class." In the classroom, teachers were placed in the line of fire for all the things they didn't think of, anticipate or predict in planning, laying the base for tensions in teaching to occur.

Each teacher had aspects of planning that indicated they did not reflect or think about the details of implementing the units in the classroom. There were no observations or conversations that indicated that teachers had developed thought experiments during which they mentally rehearsed activities to help anticipate events and consequences (Costa & Garmston, 1994). It was an area in which teachers clearly needed to concentrate their efforts, using their energies. Planning was brief, quick, with little time committed. Teachers simply found activities (Leinhardt & Greeno, 1986), rather than select by objectives (Tyler, 1950). Student needs were not formally addressed or noted by written plans. Subject matter knowledge may have been a concern, but was solved momentarily (quick fix) with textbooks and teacher guides. Four areas or sources of tension will be discussed further: 1) thinking and reflecting, 2) effort (energy), 3) interaction and social development, and 4) subject matter knowledge and teaching repertoire. These areas of tensions were created in part during planning and continued into the teaching of the units. A situation in any of these area(s) could put the teacher on edge, advancing a sense of trepidation that, unless the tension (experience) was addressed, the situation could turn into a major problem. Such tensions act as prompts to generate some action by the teacher, otherwise the tension in teaching does not go away or become reduced. Bryan (1998)

says elementary preservice teachers confront tensions of thinking out of their inconsistent vision of teaching science. Hayes (2002) suggested that tensions forced preservice teachers to consider alternatives to teaching practices and illustrates teachers' struggles to make sense (learn) about what they do in the classroom. It is suggested that teachers learn that the struggle and effort to make sense have value in their growth as a teacher

A dynamic process of relieving tensions by the teacher was set into place. It required each teacher's high energy to find solutions and answers to new experiences. She both learned from the experience and achieved a semblance of growth or simply turned the experience into a matter of survival and coping (Adams, 1996; Fessler & Christensen, 1992).

Teachers were now in a position where they had to confront the tension(s) of teaching, because once tensions developed, they didn't go away on their own and could become bigger and demand more attention.

Each tension required a response, a decision, a solution or a change in order to be reduced or removed. Tension served to designate situations (stress) and conditions that encompassed teachers' experiences in the daily teaching of their instructional units. Teachers could respond by using past experiences, new thinking, reflection and emotions. The removal of tensions represents the potential opportunities for new learning and new knowledge that could culminate after several experiences and be

transformed into microgrowth and microdevelopment (Granott & Praziale, 2002). Granott and Praziale (2002) define microgrowth and development as a process of change in abilities, knowledge, and understanding during short time spans.

To lesson or remove tension requires energy expenditure. It is suggested that the act of removing tension is potentially an opportunity to learn, particularly when it results in new teaching knowledge that is sustained in practice. Freppon (2001) has suggested that tension result in valuable experiences that lead to the personal and professional growth of the teacher.

Tensions in Thinking and Reflection

Planning and teaching are thoughtful processes (Costa & Liebmann, 1997; Graves, 2001). The three teachers in this study laid out plans to teach units without spending much time thinking about what and how to teach. They did not produce written lesson plans that indicated thinking or reflection on various aspects of teaching and learning. Almost always, lesson plans were lists (Judy), outlines of topics (Pam), or references to teacher's guides (Mary). Teachers did not indicate that they anticipated student behaviors or were predictive of assignment outcomes (Costa & Liebmann, 1997; Yinger, 1980).

It appeared the new units and activities were looked upon with little concern and were approached by the teachers as if they were already familiar with the knowledge area. Each teacher, in her own way, capitalized on past experiences. Maybe, this provided a degree of confidence, allowing them to proceed as they had planned. As a result, each teacher was left to react to new experiences, to teaching new subject matter and to working with new seventh and eighth grade students.

Judy's tensions regarding teaching started with her planning. Her teaching, compared to her written plans indicted that more had gone into planning than what she had shown on paper. Judy's thinking directed her to what she could do on the spur of the moment. Her teaching assignment, to teach science without a science background, meant both units contained new subject matter. She started by checking the resources for the middle level science. There wasn't There were no textbooks, and her equipment had to be much. borrowed from the high school science class. Judy read a lot, researched and read some more, which Roney (2001) found to be the major form of middle level teacher learning. Finally, Judy found an older textbook from which she selected chapters for both units. The text became her guide, resource and authority.

On the first day of first unit, Judy informed her students and this researcher that, "I'm not strong in science. I want you to know that, because we are going to be learning this [unit] together." These remarks not only let students know that the unit would be a learning journey for both teacher and student, it also suggested that Judy knew her students well. She knew that this class of eighteen

seventh and eighth graders would accept her limited background and would be helpful and cooperative. Later, Judy informed the researcher, "I know how to teach. I know a lot about kids. The science . . . I will just have to learn what to do." Judy was affirming she knew that the units of instruction would be on-the-job learning, but was not necessarily suggesting how the learning would occur.

Judy found that, for both units, each day was an experiment (responding to tensions) which was like "Opening a door to possibilities (Cusack, 2001, p. 71)." These possibilities served like a green light that encouraged her to think about her teaching knowledge and new science content. Tensions were relieved as a result of her teaching and the student learning experienced in her classroom. Judy saw students learning as they completed assignments, explained new knowledge during sharing sessions and answered questions. Reflection and thinking about her English and History was the order of the day and was integrated into the development of her units. Changes were most pronounced in her second unit. For Judy, each day became a constantly running mental exercise. She said, after adjusting assignments and adding new activities, "I had it (activities and ideas) up . . . in my head." Berliner (1986) and Leinhardt and Greeno (1986) found similar thinking in teachers who developed new directions in teaching without the benefit of plans or notes. Strahan (1993) saw changes like Judy's in teachers he had observed, where ideas and planning simply happened.

Mary's tensions began when she realized the "Houses" would dictate the units she would be teaching. She was aware of the contents, but had not taught either unit. Both units represented new subject matter and her minor in Biology did not prepare her for teaching Earth Science, which was the main thrust of both units. Mary's initial response was to enroll in a Geology course, but after three weeks, she realized it would not meet the needs of the units she was teaching, so she dropped the class.

It was not by accident, then, that Mary reacted like a novice teacher and placed her reliance for planning on the teacher's guidelines. For each unit, she followed the teacher's guide and selected the activities she wanted to do. Mary could not give the researcher any resemblance of a written plan and said, "I have nothing that is coherent." The researcher was once given a single page of hastily scratched notes that served as her plans, which indicated that Mary was bound to the teacher's guide for her planning and teaching. The sheet contained only page numbers and chapter headings. The teacher's guide suggested what to read, directions for lab activities, supplementary activities and questions to ask, as well as some background information.

Mary had much to learn, which accounted for her many tensions. She had to deal with new subject matter, labs and field trips that contained teaching strategies with which she had little experience. The situation was predictable according to Kennedy (1991), who found that possessing a degree in science does not guarantee the kind of subject

matter knowledge needed for teaching. Friedman (2000) reported that, unless the science content (Mary's biology) is closely related, the knowledge of one discipline does not transfer to another.

Pam's thinking and reflection were limited to planning her second unit and her subsequent development of tensions. The first unit had been designed a few years earlier and was taught with plans that had been committed to memory. The rigid structure curtailed most tension development. This structured thinking was carried to her second unit, where she maintained the routines used in the first unit. This was her preferred choice of teaching, which left the new subject matter and assessment to be learned. Both new subject matter and assessment generated tensions. Acquiring and committing the information to note cards lessened the new subject matter needs. The assessment strategy, on the other hand, produced greater tensions since Pam was trying to use posters and student reports. This was Pam's first venture in assessment outside of testing, and she worked very hard to be sure that every student produced a poster by providing all the materials, ideas and opportunities for assembly.

The first part of Pam's classes included the routine of checking homework assigned the day before. In the two seventh grade classes observed and during two units, Pam followed her routines faithfully, taking about thirty minutes every day, which was nearly fifty percent of the period. The rigor of the activity demonstrated that Pam did not perceive tensions at this time. The potential for tensions was present though, and would occur when Pam perceived that her routine or schedule was upset. Some of these tensions were associated with the student interaction portion of the routine, to which she contributed. This portion will be discussed under tensions of social development.

It is suggested that Pam's thinking and reflection, at this time, were on hold. The rigor of the routine did not require that she expend much energy to copy the basic plan of unit one to unit two. A number of times Pam said, "I don't have time for reflection," something other teachers have also said (Hanson, 1998).

Pam's homework routine was very structured. Homework was checked by stamping, a process to show that the paper was completed. The "Stamping" section was not structured and consisted of unplanned teacher-student interactions. During this time, Pam demonstrated a reflective, intuitive nature and a high degree of spontaneity. As the stamping proceeded, students sat and waited their turns as Pam spoke with each student. During stamping, Pam demonstrated her concern for her students, such that each student was recognized as an individual. She let each student know they were special and urged him or her on to better achievement. Pam spent anywhere from a few seconds to minutes with each student. The longer conversations indicated Pam had indeed reflected about a student and his or her needs before the stamping began. Pam suggested to one boy that she would set time aside for him to come after school for help. One boy had done exceptionally well on the previous paper, and Pam

spontaneously congraduated him, shook his hand, and made him both proud and flustered at the same time. No such detail appeared in her lesson plans or notes, suggesting Pam had moments of reflecting-in-action (Schon, 1983) in teaching.

The spontaneous nature of Pam's talk with students contained situations, events, promises and appointments that had tension potential. She might forget. Pam's nature of frantic busyness led her to write quick notes on the blackboard, only to erase the board in her haste before she noticed the messages. Each forgotten appointment and promise would produce tension for Pam. Previously, Pam had run out of time, which had prevented her from fulfilling promises. In the second unit, Pam had promised to find Olympic pictures off the computer for students, only to run out of time and not get it done. This bothered her, so in class, she went to greater extremes to see that the students had pictures, a requirement for their posters.

The teacher thinking and reflection literature suggests that many teachers do not possess thinking and reflective skills (Cross, 1995; Garnett & Tobin, 1984: Jungwirth, 1987, 1989, 1990). Teachers with thinking skills often elect not to use them (Cornet, Yeotis, & Terwilliger, 1990; Jungwirth, 1989, 1990) unless prompts are present to help generate thinking or reflection. It is suggested that tensions are typically healthy prompts, as was illustrated by Judy, forcing the development of thinking and reflecting skills that awaken responses to the needs of teaching. Thereafter, each successful solution removes tensions of teaching and is transformed into pieces of learning, microgrowth and development.

Tensions in Energy Dispersal

Tensions in teaching were observed or demonstrated in the way each teacher dealt with the dispersal of her energy in planning and teaching. None of the teachers expended much energy in the planning phase, which appeared to be a time saving strategy.

Judy operated with a high degree of energy. She worked hard to form a strong relationship with her students and the school. She did not say "No" to the many requests for help. If there was something to be done, she did it. Overheard from community member(s) were comments on how much time Judy put into the school and the kids, such as, "Boy, I wouldn't do it." Judy arrived at school early and stayed late.

When Judy started the teaching phase of the first unit, she had already experienced the internal tension of her weak science content background. With her Art, English and History background, Judy did what new teachers do with a class that has no textbooks. She found a single copy of an older biology textbook to use as her guide, resource and authority. She read a lot (Roney, 2001) before picking the chapters that became her units. Her twelve years of teaching self-contained elementary classes gave her some idea of science, but that had been many years earlier. She selected the topics, read through several books, and then chose the book she felt most comfortable using.

Judy's energy would not allow her to just follow the book. After the initial activity on the microscope and single celled organisms, she was prompted to change her The book was using only one technique. As she approach. said, "I didn't like that." Judy modified and added to activities while student work was in progress. She would pause when giving directions or when monitoring students as they worked, which meant she had perceived something and was thinking about it. Schon (1983) called this reflection-inaction. Judy had seen something, and after a moment of thinking, she would call for a "Wait-a-minute, let's think about this some more." This departure would result in a change in the direction of the work in progress, which would add time to the present assignment. It could add or expand a related assignment, provide more information, or have students share their new knowledge. As Judy reduced the tensions of teaching, she was gaining bits of new knowledge and confidence in her practice (Panasuk & Sullivan, 1999), both of which are the components of a self-directed (Grouws & Cramer, 1989) individual involved in her own microgrowth and development (Granott & Praziale, 2002).

Judy was getting better at letting her extensive background in Art, Language Arts and History creep into her science teaching. Her reflections demonstrated connections with reading. In one class, she read a mythological story about naming spiders (Arachnid). As she read, her students were excited, remembering the book she was reading from, listening intently and asking wonderful questions. Judy's

teaching was being energized (Graves, 2001). The students were being energized, as well, nodding to confirm each other's comments. They knew the answer or remembered when another student answered. Judy was also learning that in future teaching she could wrap science topics, in this case, invertebrates, with Language Arts. There was also a strong indication that Judy's confidence was matching her increase in energy as the tensions of teaching were reduced. Both her increased confidence and energy level contributed to her assurance that it was safe to continue to think and reflect over her units and her students' needs. Judy's growth originated from the energy of learning and the pursuit of the unanswered questions (Graves, 2001) and demonstrated that growth was a process (Costa & Garmston, 1994).

The other two teachers, Mary and Pam, saw their energies being used up in alleviating the tensions of teaching. The learning and teaching of new materials and techniques were consuming Mary's energy. Despite her Science and Math backgrounds, she was not able to adapt and apply to either unit's subject matter. Mary's task was demanding. Not only was she learning about the characteristics of healthy streams and rivers, but she was also learning how to perform several water quality tests and conduct a lab investigation, something in which she had little experience. Mary then had to teach students how to perform the tests in the field, conduct two field trips to collect water quality measurements, and later compare results to several years of previously collected data. Mary had neither organized nor conducted a field trip before. To compound matters, she had two large seventh and eighth grade combination classes of thirty-two students each, consisting of eighth grade students she had known the previous year and new seventh graders. Teachers who taught the unit in previous years had been able to use local water quality experts in the classroom who literally taught the water unit for them. Mary found no local help available. She only had the assistance of a student teacher twice a week and the visiting researcher, who helped set up the stream tables. Her tensions in teaching must have begun to develop when she realized that the teaching of both units was her responsibility.

Mary's energy appeared to wane in meeting the tensions of teaching the first unit. On several occasions, she was observed to be unprepared to start her first class. She began the class by using time to prepare a class assignment as students chatted. This behavior occurred after a long weekend and once more upon returning from a three-day workshop. As a result, the tensions of teaching were still present and larger than ever. Tensions of teaching do not go away when they are unattended to. She gave students ten minutes of "chat time" to write an assignment. These actions contributed to more tensions. Mary lost teaching time, as well as contributed to student behaviors that required monitoring and management, and required her to rush through the remaining activities, reducing the lesson to a half-hour of note taking. She did not provide for questions and answers or check for understanding.

Mary's second class began five minutes after the first. She made no notes during the first class, but by the end of that first class, she was more prepared for the second. The rehearsal of the first class prepared her instruction in the second class to be more effective. What was not clear to students in the first period was clear to students in the second. What took ten minutes in the first class took seven minutes in the second. Mary asked more questions of more students and they were given time to think and answer them. Questions were framed better, and she used the teacher's guide less often. It appeared that Mary's first class served as a dress rehearsal (learning) for the second class and what appeared as energy-draining in the first class energized the second class. What transpired between the first and second class suggests that Mary's energy reserves had been refueled through reflection as she was teaching the second class and she felt better about what she was doing. Learning was occurring through registering what she saw, such that it resulted in the adjustments for the second class. The tensions experienced in teaching the first class were not noticed in the second. Mary demonstrated that her energies were lasting when she reflected-on-action (Schon, 1983) after one class, "I think the instruction in the second class was better. What do you think?" Later, in the second unit, Mary alternated the order of the classes, second to first.

Mary's experiences with the tensions of teaching continued to sap her energy. On three occasions, she ended her day with a big sigh that seemed to imply, "I'm glad the

day is over." On another occasion, her frustration showed in the comment, "They [students] are just not getting it." Her student teacher asked what she was going to do and she said, "I don't know." She avoided any connection between her frustrations in teaching and her teaching strategies, and she tended to blame the curriculum and students for her tensions.

The third teacher, Pam, was a blur of movement. Her energy was never in question, but it was an agitated type of energy and dependent on time schedules. She flitted around the room, seemingly always doing, looking, finding, moving or preparing something for the class that was about to start. If she couldn't get everything done and the class was coming in, she would jot a note on the blackboard to herself. She greeted students with high enthusiasm, selling them on the idea that she was sincerely happy to see them. Pam was energized, and she energized her students.

Pam's energy became clearer in her daily classroom homework assignment routine. She was not aware of any tensions. Her energy evoked her intuition (Atkinson & Claxton, 2000) and thinking, such that she made a concentrated effort to make contact with every student. In later conversation, she said, "Students need to learn things besides just content." This was never written into any of her lesson plans. Pam actively talked with students about a variety of student concerns, and she worked her concerns into the conversation, as well. She used this homework time to generate a closer relationship with each student, and/or to know each student better (Jackson & Davis, 2000). In this
regard, there was a connection, an overlap between her energy and student social development, which will be discussed more in the Tensions of Interactions and Social Development section.

Pam's energy had a nervous, on-edge quality. It appeared she was doing many things because she was constantly on the move, from looking for something to greeting students when they entered the room, "Hey, John! How are you doing?" But, tensions were particularly evident if she wasn't ready for her first and second classes, which were the observed classes. On two mornings, Pam was behind, entering grades into the computer for papers she wanted to return that morning. She made the first class wait several minutes, putting her behind more and forcing her to make up time in her schedule. As she worked, she chastised students for talking too loudly, enhancing the mounting tensions by her increased intolerance. At other times, student talking did not evoke any comments from her. Once the papers were ready, Pam quickened her pace. She had to get back on schedule. She hurried, dropped things, not even picking up a pencil that rolled to the floor or righting an empty vase that was tipped over. Tensions were reduced by a simple adjustment or dropping parts of the lesson which equaled a quick fix. On another occasion, Pam forgot about a 7:00 AM staff meeting that conflicted with her self-developed prep time. This was the time she made copies, cleared the blackboard, readied transparencies, and entered grades into the computer. This day, she didn't have everything ready, and students were

coming in a few minutes. This, she said, sent her "Into a Tizzy." She was rude to the researcher and students, with no smiles or greetings, only curt comments. Students were chastised for anticipating the first activity and told to, "Sit and don't anticipate!" The researcher could sense the tensions building and offered to help make copies, but Pam replied in a curt and dismissing manner, "I don't have time to delegate now." Her voice and speech conveyed a greater tension and a mounting concern about the observation of the first class that was to follow. She suggested, more like a command, that the researcher not observe the class. The researcher agreed and returned the next period. Pam had regained some of her composure or lost some of her "Tizziness." She smiled a little. She apologized for her behavior and requested help in making some copies. It is not known if she apologized to her students. Later, in the interview, Pam talked about losing her prep time, "I need my time to get ready." It was noted that Pam did not suggest that maybe she could be ready earlier, rather than waiting to prepare until just before class.

The episode above suggests that Pam's perception of the lack of time and unprepared materials for the routines she had established had a high-tension potential. Her planning was based on a tight schedule, which required the materials to be ready. Any deviations put her off schedule. Pam's first class had to be right, because her second class was taught identically, even though students were different, with varied skills and abilities. Pam's energy was directed to getting back on schedule. In the "Tizzy" episode, the copies the researcher made allowed her to pass out homework during lunchtime, which resulted in being back on schedule.

These experiences for Pam resulted in no changes that constitute learning or growth. She didn't suggest in her interview that she would change anything and continued to prep for her first class in the morning. Her tensions were momentarily decreased, but not eliminated. Pam's busyness continued to present the possibility of running out of time or not being ready, such that later in the year, her energies could wane. She noted in her interview, "I just seem to run out of gas at the end of the year."

Tensions in Subject Matter Knowledge and Teaching Repertoire

New subject matter, unfamiliar textbooks and teaching guides produced tensions in teaching that each teacher had to face. Judy's and Mary's tensions were over subject matter knowledge and teaching repertoire for both units, since the content of each unit was new. Pam's tensions were just as forceful, but they were concerned with the subject matter and new teaching methods in the new second unit. It is probable that no teacher saw the learning of new content as an individual change process (Fullan, 1982; Hall & Loucks, 1997), as being self-directed (Routman, 1996; Korthagen, 1993; NRC, 2000), or as a process that was personal and involved learning (Baird, 1992; Guskey, 1986; Mezirow, 1991; Powell, 1997); however, each teacher had experiences involving the change process, self-direction and personal

learning to some degree. The teachers in this study saw learning new subject matter as something they had to do because they lacked subject matter knowledge, which promoted tensions that prompted immediate responses. Thus, the teachers did not see that learning new subject matter would result in their own learning and a change in their practices, which would promote their own growth and development.

Judy, initially, appeared to be handicapped by her weak knowledge of subject matter and high tensions of teaching. On the first day of the first unit, she began to reduce tensions involved in teaching middle school science by informing her students and researcher that science was her weakest area. The students received this information without any comment. It seemed that her students knew and understood their teacher and that they would do their best, knowing Judy would do her best to help them.

Judy exemplified the notion that there is more to planning than just writing something down, even when subject matter knowledge is extremely limited. Straham (1993) found that teachers in his study did not write lesson plans and that teaching just seemed to happen, implying that the teachers' lesson planning was in their minds.

Judy didn't lecture, since lecturing was a tension for her. She admitted that she was afraid she would say something wrong, didn't have that much to say, and her confidence wasn't high. She said in retrospect, "I could only lecture on what students were reading, and that served no purpose." Judy also felt that lecturing was an open door

to questions and reflected, "I couldn't do that, but I could find someone who knew the answer or find out myself." Students asked questions and prompted Judy to respond by reframing her teaching experience and developing new strategies to meet the tensions of content questions. Questions she could not answer were directed to the class to see if anyone knew the answer. Often someone did. If there were no answers, Judy would suggest several possibilities to the students, and/or she would find the answers to questions by the next day. This happened many times, and the next day, she or the students had the answers. Judy and the students then shared what they had found with the other students. The researcher recalled how difficult it is for a teacher to remember promises he or she makes on the spur-of-the moment, without writing them down (Cummings, 2000). Judy didn't write anything down, yet she remembered every time. She couldn't explain how she did it; she just could. She explained that she might have been aware of the strategies to deal with student questions but that she had not used them before. She was pleased with herself that the new strategies worked, and she carried them through the second unit. The satisfaction that she displayed over the removal of the tensions from questions and lecturing suggest her new learning and knowledge, which transformed her experiences into small pieces of growth and development that could sustain the practices throughout the year.

Another tension was in dealing with the inaccuracy of the older textbook Judy was using. She said she could not

tell when the textbook was inaccurate, so she never questioned what the book said. Often, she would say, "My book said . . . ," to establish that the book, not she, was the authority. Students helped Judy to reduce the tensions of book accuracy by often going outside the book to complete assignments and adding to class knowledge. This turned out well for Judy's learning and growth. Judy had developed a classroom where students felt safe to challenge the textbook. Judy accepted student challenge, and, in fact, it appeared at times that she encouraged and endorsed their efforts as a way to counter the tension related to the question of textbook accuracy. In one case, Clara's (student pseudonym) answer to the question was nowhere near what Judy's textbook gave. Clara challenged the textbook by saying she had found the information in a new book on invertebrates. Judy asked for the name of the book, and Clara told her. Judy accepted the new information and thanked Clara for her help. She then asked Clara to share her information with the class, and the students wrote the information into their notebooks.

Judy experienced another tension that was associated with subject matter and assessment of student work. Judy said, "I don't feel comfortable giving a test. I can't tell if their answers are correct." Her solution to the tension of assessment was to implement methods and strategies she had used in teaching other subjects, which raised new experiences. The new experiences demonstrate that she could adapt her teaching needs to learning as a way to reduce the tensions of subject matter inadequacy. Calderhead (1989)

found that transforming out-of-content teaching knowledge between disciplines is difficult to do. By the second unit, Judy's confidence was high, prompting her to often reach into her "Reframing" bag of previous experience. Russell and Munby (1986) called using methods and strategies from other disciplines as "Reframing." As such, Judy stumbled into the practice of integrating subject matter. The discovery led her to deliberately integrate and to frame Art, Language Arts, History and Science into the second unit. She reflected, "I was integrating. I like that."

Judy realized (reflected) that she had a wealth of knowledge other than science knowledge, and that this factor improved her confidence to teach science (Appleton, 1995). Bencze (1999) suggested that a teacher's discovery that she could design curriculum and not have to depend upon the "recipe" activity (textbook) was a confidence builder. Judy was gaining confidence in herself, her thoughts toward science, her ability to decide, knowing that her students were learning, and implementing her unit. Thus, she was able to relieve tensions in subject matter knowledge by recognizing her need and to search for answers (Grouws & Cramer, 1989; Ovens, 1993), to question herself (Paley, 1979), and to question her teaching. Her tensions were either reduced or removed, not by adding more science content, which would not have helped her to know how to teach but would have just added more content to teach. Judy advanced her learning by taking charge (Routman, 1996) of gaining knowledge in teaching by combining science content

with other disciplines, both to her advantage and to the benefit of her students' learning.

There is an important overlap of reducing tensions of teaching, increasing energy from past experiences, and the wide array of teaching strategies Judy used: concept maps, Venn diagrams, artist role, writing stories, telling stories, discussion, poetry, myths, along with the science activities. It is noted that Judy, with a greater teaching repertoire, was given more opportunities to frame activities and to learn, grow and develop in the process of teaching science. She had not confused the range of instructional strategies with changes in curriculum topics (Wasley, 1999) when she combined her teaching strategies with science.

Mary's tensions were also associated to new subject matter knowledge and unfamiliar teaching methods. The earth science focus of the new units was not covered well by her Biology background. Also, both units were very hands-on lab investigation activities that demanded daily preparation, management and manipulation of much equipment and many supplies. Both units had a teacher's guide, but no textbook. Student readings were copied from the guides.

Mary's tensions were directly linked to her limited subject matter knowledge and her reliance on the teacher's guides. Mary was not encouraged to think because the teacher guides did it for her. Several local science people who were involved with the unit since its inception had previously assisted the Rivers unit. They were not available, so all aspects of the unit were Mary's responsibility, and she was being overwhelmed. The river unit was based upon long-term measurements of streams and rivers. This meant that Mary would have to make sure students in two classes knew how to perform the tests and conduct a stream survey. An earlier weekend field trip was taken to provide a foundation for each student to learn how to perform the water quality tests and conduct a stream survey. Now, it was up to Mary to see if students remembered how to do the tests for the field trips, to gather data about clean and polluted streams. The first trip followed within a few days.

In order to meet these tension demands, Mary's teaching was teacher-centered and structured. She took the teacher's quide with her to the overhead and lectured. On one occasion, Mary tried to enlist the first class to help plan the field trip. She asked the students how they would prepare for surveying a stream. After a couple of brief student comments, there was silence. Mary recognized the silence as an indicator that students could not perform the tests without further teaching. This presented Mary with a new tension of teaching, since she thought students would be able to describe a stream survey and select a part of the survey they could do. She found that only a few students could perform one or two tests out of the nine that were needed. Mary did not ask any questions that suggested she knew how to do a stream survey herself. Mary's solution to the mounting tensions was to change her teaching tactic. She assigned tests and procedures to groups by asking students, "Who can do the dissolved oxygen test? Who can do the stream

bottom survey?" until all the tests and survey parts were assigned. This took most of the period and left little time to go over the expected behavior and proper dress for the field trip. In the second class, Mary dropped any idea of having the class participate in the planning of the field trip. She moved directly to checking who could do the tests and made assignments. By their responses, the second class of students knew how to do every aspect of the water quality survey. It appeared this group could have done very well with helping her plan the field trip had she tried that technique with them, but Mary had given up on that strategy. Mary did note that the second class went smoother than the first class, and said as much, "Boy, that went smoother."

Mary's unsuccessful experiences at having the first class help plan the field trip prevented her from trying it in the second class. It may prevent her from trying in the future, a case where the tension of teaching developed a negative teaching experience.

Mary struggled with the field trips, with herself, and with her confidence. The first field trip resulted in the students' inability to do very much in the field, which contributed to her tensions of teaching, particularly since she had to do a second trip in a few days. Students had arrived unprepared for bad weather: no boots, coats, or rain gear. They were unable to perform the water quality tests or take responsibility to do them well and accurately. The descriptions of the surrounding vegetation and stream bottom could not be used as reliable data. Lastly, students behaved poorly. Mary had taken note of what was going on. Later, she and the student teacher returned to the stream and collected the data for the comparisons students were to make in the class.

Mary's reaction, or tension reliever, was to move on. There was no debriefing or comments about the first trip, just more teacher-centered structure for planning the next field trip. The next trip involved bus travel and two locations with both classes and extra adults. Mary assigned tasks and solicited pledges that the students would be able to carry out the tests assigned. Mary took several minutes to inform students to dress properly and that those who did not would still go, but she would not listen to their whining. Those students who found ways to get out of the field trip received extensive assignments or failed. The second field trip went very well. Students behaved much better and were able to take the measurements for two streams.

Mary's tensions continued to be present through the first unit and into the second. These tensions were related to her subject matter knowledge and preparation. The River Cutters unit required lab investigations nearly every day. There was hectic, tension-building preparation every day in order to be ready for the second class, which followed immediately after the first period class. All the equipment had to be set up again, fresh supplies readied and distributed, and stream tables leveled. The student teacher and the researcher really helped. After a few days, Mary's solution was to change the scheduled classes, such that she would have one class two hours each day, every other day. This schedule essentially reduced the preparation to once a day and eliminated the associated tensions of multiple preps.

Mary's tensions continued. She was unable to make adjustments in the methods employed in the unit. The lab investigations required stream tables to model the development of a river over time. Mary's stream tables were long and laid too flat. There was not enough slope and the rivers could not form over the length of the stream tables. The student teacher had the students raise the stream table by the thickness of a 2" x 4" board, but Mary insisted they take the boards out. After another attempt and the same lake-producing results, Mary relented and had the 2" x 4" board put back, and everything worked well. During a break, Mary came to the researcher and said, "I don't know why . . . but I have a hard time changing anything in the book." Rockcastle (personal communication, June 1989) found that teachers had difficulty substituting materials and methods in science lessons. This researcher found that elementary teachers would stop using science kits and science lessons, because they did not understand how to replace materials or develop substitutes. In one case, it was the simple matter of replacing broken beakers. It appears that Mary's content and lab method knowledge was the culprit. Mary's tensions of teaching would not go away with these experiences.

In another example, the teacher's guide suggested connecting the river activities to reading a historical poem

about rivers. Every line of the poem was highly metaphorical about the history of "Rivers" and the meaning to man. Students were to discuss the meaning of each line. The students could not do it. It wasn't that Mary had underestimated her students. She didn't think of that. She was simply following the teacher's guide and did not consider the student abilities for this kind of thinking. It fell to Mary to explain each line. Mary had to use the teacher's guide to explain, but the guide did not provide much information, and it appeared that this kind of thinking was new for her, as well. Her hesitations and pauses illustrated her search for words and ideas to explain, and when she ran out of explanations, she ended with a knowledge gap generalization, ". . . and things like that."

Mary's lack of subject matter knowledge for both units was evident. Solutions to relieve the tensions were inadequate. The tensions of teaching were still present, and in some cases, increasing. Mary's daily experiences were often frustrating and sapped her energy. Britzman (1991) noted that when a teacher is coping with a difficult situation, she could turn negative experiences into a sense of detachment. On two or three occasions, Mary's day ended with a big sigh, which might have implied that her discomfort was over and the comment, "I'm glad the day is over!" Or her frustration would show, with the comment, "They . . . are just . . . not getting it!" "How come?" the student teacher asked. "I don't know," was Mary's response.

Mary's daily experiences only led to more tensions in teaching. It was clear in both units that Mary never felt at ease with any part of the subject matter or methods of teaching. It is here suggested that Mary's weak teaching repertoire will always be a source of tensions. As long as Mary views content and methods as residing in an external authority (Hofer & Pintrich, 1997), she will always find it difficult to change. Mary's negative experiences in being unable to resolve her tensions of teaching are conditions that do not promote teacher growth and development.

The third teacher's confrontations with tensions in teaching were always associated with time. Pam's content knowledge was generally not in question. She was a science major with extensive work in science as a park ranger. Pam had designed both of her units. The first unit had been taught before, and the second one was new. The new unit required collecting a variety of text materials, preparing activities, and learning new subject matter. Kennedy (1991) noted that having a degree {in this case, Science} is no guarantee that it would include the subject knowledge necessary to teach. Gaining new subject knowledge and trying a new assessment method would be sources of tensions to Pam.

Pam avoided tensions associated with methods of teaching by limiting her repertoire to her preferred choice of teaching - lecture. She did no labs, no demonstrations, and had no variations in assignments. Pam's solution to any lack of specific subject knowledge was to research and review the material she wanted students to learn. She developed a

series of note cards with the information, since the information was not entirely internalized, and she read the notes to her students.

Pam was the classic candidate for the "Drain-of-notenough" (Richardson, quote in Graves, 2001) award. Time and the lack of time were a tension for Pam. There was not enough time for labs and experiments. Pam's busyness was attributed to her desire to do as much as she could with the time she had, and this meant she had to talk and tell students what they should know. Her tensions developed when time was running out and she saw she had much more to do.

Pam, in her six years of teaching, had built a daily schedule of teaching routines, consisting of activities surrounded by discussion and student contact. Any deviation from this constituted a crisis. Potential tensions loomed great because Pam started each morning with a self-designed morning prep period (one and a half hours) before school started. Each morning she would get ready for that day, making copies, preparing lessons, new materials and transparencies, cleaning the blackboard, and grading papers that had to be returned that day for discussion. Though the researcher tried to develop conversations during this time, it was never a sure thing. Pam was often on the run and too busy. Her comments or answers to questions were given as she passed. They were quick and short. Once or twice, she said, "I don't have time for this," as she left.

Another tension of teaching for Pam was in the new unit. The new unit had new subject matter to be learned and

taught. Pam's solution was to gather information and put it into her basic teaching format. She prepared note cards for her lecture-explanations. These notes were used during an activity, which had students watching Olympic athletes in action. As students watched, Pam would tell students {from her notes} what she wanted them to see and know. The activity was repeated for several events. During the activity which extended over several days, students asked questions about the new subject matter, which Pam could not answer. This was atypical for her, as she often used student questions as a major way to talk and give more facts. Her response in this case was most often a spontaneous general knowledge statement rather than scientific knowledge. In this way, any resulting tensions were fixed quickly.

Overall, Pam's tensions were kept to a minimum by keeping to her routines and schedule. Only the lack of success of the unit as a whole could be a source of tension. Pam admitted in the exit interview that she was satisfied with the content, but not the delivery and methods. In saying this, she was not referring to herself but to the older equipment she was using, which did not work well. Thus, Pam was not recognizing that she had anything to learn. Asked if she would teach the units again, she said she would. Asked if she would change anything, she said, "Oh, I don't have time to reflect." Pam's teaching and engagement in tensions resulted in experiences that did not produce or stimulate growth. Her new content knowledge, featured by note cards, simply reinforced her chosen method of teaching.

Tensions in Social Development

Tensions in teaching and social development (Turning Points, 1989; Jackson & Davis, 2000) include all aspects of student contacts, interactions and relationships. The middle school and young adolescents' relationships with adults form the pathways to their learning (Jackson & Davis, 2000; Turning Points, 1989). Social development is a foundation of the middle school philosophy, which establishes that every middle school student should be known well by at least one significant adult. The teachers in this study were at crossroads on how much of themselves they could commit. In an, "Emotional labor," teachers tried to work at establishing bonds and forming relationships (Hargreaves, 1997) with students and making them feel safe (Beamon, 1993). Teachers with energy and dedication are self-sustaining when it is supported by teachers who are principle, have a strong sense of responsibility for student learning and search for their own strengths (Ayers, 1993; Graves, 2001). The tensions associated to social development tended to develop out of whether or not a teacher was serving their teaching and students' needs.

The ensuing discussion is about each teacher's approach to develop relationships that promoted social development. Teachers vary in how they encourage and allow students to interact with one another during academic activities. Judy's tensions of social development were healthy. She used tensions to advance her advocacy for students to learn more things than just science. Cattani (2002) suggested that advanced thinking, such as this, illustrates reflective thinking and shows that the teacher "Cares" (Noddings, 1992) enough to feel invested in her students' academic and social development. Judy carried this out by her work, both in and outside the classroom. She organized student projects that allowed students to develop business skills outside the school. She confided that she felt she had to do it because there were so few activities for the middle school students. Inside the school, Judy placed strong emphasis on students working together and getting along by independent and cooperative work. Judy worked consistently at interpersonal relationships, teacher-student and student-student

Judy explained in an interview that she was very deliberate in advancing the whole child (social development). Her activities always allowed for students to interact, but she never spoke of addressing students' needs as social development, as if it were planned. Social development never appeared in written form, suggesting again, that many parts of planning are mental activities.

Judy's solution to tensions began with cooperative work, usually in pairs. She changed the pairs often and was careful to consider who was working with whom. In the group, students worked together and separately. In either situation, students shared their learning discoveries. Judy did this by having students discuss with each other and to the class, and not to her. The class asked questions and made comments. Judy might follow with more questions or

comments, and end with the statement, "Does that make sense?" Students were quick to respond if it made no sense. It was an easy matter to ask, "What didn't make sense?" And the students would respond. Students were given the first opportunity to answer. Judy would thank each student as they finished, "Thank you for sharing." She meant this wholeheartedly. She said, "I can't say 'that's good' . . .I couldn't do that. I want them to know their risk-taking is worthwhile, so I thank them for sharing with the class."

Judy made it a point to know her students well (Turning points, 1989; Jackson & Davis, 2000). To establish knowing her students well meant to care, which means she saw, heard and felt what others were trying to convey (Noddings, 1992). Judy knew the special-need students and made provisions so they were able to share in every part of the activities. She checked with them often. Her tensions in this area were only to stay consistent and constant in her efforts and be ever cognizant of moments that served her goals in these directions. One knew that Judy was serving the needs of the students, because the students were at different places on different assignments. She anticipated student absences, prepared for them, never failed to check with them should they need extra help, and let them know she was available after school. Judy would inquire about a parent, a brother or sister who might be in college or someone who was ill and would wish them well. Judy made sure that no student was left out of a discussion. Even after a student may have passed on an opportunity to talk, tell a story, answer or ask

a question, she would return to them and say, "Do you have something to share?" Judy was demonstrating a teacher responsible to her student needs while avoiding tensions that could not develop in an atmosphere of motivating student learning.

Other tensions demanded teacher and student interaction. Grant (2000) suggested that teachers look closely at students and use the information to make instructional decisions. A strategy of teaching Judy employed to alleviate tensions consisted of on-your-feet thinking that translated a pause into action. On one occasion, Judy noted students telling their partners about an experience with Jellyfish. It was an opportunity, a tension Judy had about missing a moment when students could share. Judy had never allowed that students speak to her, but rather to their classmates. Classmates listened and asked questions. What started as one story gained momentum and soon became ten students telling their experiences. Judy didn't miss this one, and it fit well into the unit on invertebrates. Students came away with a firsthand understanding of nematocysts, stinging cells of Jellyfish. Judy had shown herself to be an "Opportunistic planner (Berliner, 1986)," and capitalized on the moment.

Judy's tensions in this section have to be looked at as healthy, ever-present educational prodding, minute forces that keep teachers like Judy alert, and in this case, to meet the social needs of students.

Mary, on the other hand, may have been too busy contending with the tensions of subject matter and methods of teaching to be concerned about the tensions of social development. Mary's interactions were less personal. Her preparation kept her busy right up to class time, and often beyond. Her activities were directed to the entire class and no phase of her planning indicated she addressed special need students. It appears some teachers at a school can be concerned about student needs, and others next door may not be concerned at all. It may be that Mary was concerned, but she was at a point where taking on more tasks required more energy and time than she had left. Mary's interview, weeks after the second unit, confirmed she had a great concern for students. She was involved in a program that was looking at why students fail and their social needs.

Mary's interactions with students demonstrated a tension in using groups and lab activities. She said she was not used to the "Pandemonium" involved when students were working on lab activities in groups. Mary's concern for the pandemonium suggests little experience with these methods of teaching. Grouping students wasn't a social measure, but one to accommodate the physical limitations of lab equipment and large classes. Mary took great care in forming groups, making an effort to place students who would learn how to work together. Mary had anticipated students' moans and groans when they heard who was in their new group. Mary curbed student comments by suggesting they act as young adults and learn how to get along with other people and work

together. She was successful. Students did not comment on their group assignment.

Pam's approach to the tensions of social development covered a range of actions and reactions. Her planning did not address social development or student interaction, but Pam mentioned, on more than one occasion, that students had special needs, besides learning science. In this regard, Pam's reactions to social development of students was spontaneous, reacting and responding more on intuition (Atkinson & Claxton, 2000).

Pam's tensions of social development arose out of incidents in the classroom, and it appears she took her cues from interactions with students. On several occasions, Pam would stop in the middle of a science explanation and raise a point that was clearly a topic of social development. For example, once Pam stopped, raised her voice and proclaimed, "Over that door is a sign, 'Those who enter must do quality work.'" At this announcement, there was a hum and Pam's seventh graders looked for the sign. There was no sign. There were puzzled looks. Why did she say that? Pam was still gaining knowledge of students. She began to speak about the meaning of quality. As quickly as she started, she ended the talk and resumed the lesson. In this manner, Pam could speak about the importance of speaking kindly to each other, no "Cuts," writing good sentences, choosing to do good work, choosing not to bother peers during learning. Rules were the same for everyone and celebrated the differences between peers. In the latter case, a short boy student had

made a disparaging remark about a very tall (6') girl. Pam said to the students that we are who we are and should be proud. "Stand tall, Ann, stand tall."

A second area of tensions was related to the importance Pam placed on her homework routine. She had built in the routine time to talk with individual students. The fact is. she came out of this activity knowing her students well (Jackson & Davis, 2000; Turning points, 1989). It occurred during stamping of the homework. Stamping was just a matter of putting a stamp on papers, but Pam, intuitively and spontaneously (no plans), took time to develop a conversation with every student. This was every day. The conversations involved forming some kind of relationship with students (Cattani, 2002). The talk covered a variety of topics that seemed pertinent for each student. She told the boy who needed extra help, "Well, it looks like you should come to see me for extra help, right?" The boy agreed, "Okay." То another student, she might comment on a new shirt or a nice haircut. She told another boy how pleased she was that he had done so well on a test. Pam knew how many points a boy or girl scored in the basketball game the night before and would congratulate them. Or, she might let a boy know she had learned he was now on the swimming team and that she thought that was neat. Often Pam would show her excitement and enthusiasm by extending her hand to shake hands and congratulate a student. Students were hesitant about shaking hands, but did so. Not many teachers let students know that what they {students} do is special. Pam would pump a

student's hand and tell him or her and the class how wonderful that the student was doing something. Students didn't say so, but they liked what Pam did and were pleased that Pam had featured them that day in a class of peers. Pam made sure she contacted every student, while at the same time eliminating any tensions that were present. The homework sequence averaged fifty percent of the period. In the second class, she would repeat the contacting process, emphasizing that she was aware these students were different students with different needs.

Summary of Tensions in Teaching

The purpose of this study was to explore the impact of planning and implementation of planning (teaching) on the teacher's growth and development after teaching two units of instruction, one "Regular" unit which had been taught before and one "New" untaught unit. Pam taught a "Regular" unit and a "New" subject matter unit, but Judy and Mary each taught two "New" subject matter units. Since it was the teaching of "New" units that was the focus of the study, it was considered a benefit to find teachers who were teaching "New" subject matter units as a normal practice, essentially doubling the data that could provide evidence of growth.

As a teacher, the researcher found that his lesson failed when he did not plan well. The failed lesson occurred when time to think a lesson through was incomplete and/or a lesson was simply pulled out of a magic bag of resources and given to students, "Here . . .do it." The researcher found, in retrospect, that he was attempting the impossible and was separating good planning from good teaching.

The three teachers in this study did not formally plan their two units, but there is ample evidence that they taught more than was written down, and students experienced more. The practice affirmed what Costa and Garmston (1994) found, that more goes on in planning than simply writing something down. But, by not writing down their plans, they did not think through their units, leaving much to chance. It opened the door to stresses and forces that became tensions in their teaching.

Each teacher was very different in her approach to planning, implementation of planning (teaching), and response to tensions. These differences were in responses to tensions in teaching that define whether or not a teacher would have positive and meaningful experiences that contribute to her continuing growth. Barrel (1995) noted that particular experiences are stressful and problematic (tensions). Tension experiences can be positive and lead to healthy outcomes over time and result in growth and development for the teacher, such that a teacher with twenty years experience is a teacher who has grown steadily every year. As such, experiences in teaching have a quality of an event or action character that has a past-future structure (Clandinin & Connelly, 1991). Every experience exists, in part, from the past, because of its influence on the future (Clandinin & Connelly) and by the alternatives that occur in the

environment and the internal conditions of the teacher (Dewey, 1938).

Tensions had size: big or little; direction: positive or negative; and outcomes: healthy or unhealthy. Tensions were the stresses, forces that prompted teachers to do something immediately. Tensions created anxious moments or concerns about something that wasn't going the way that the teacher thought it should go. The teacher who forgets to mention how to handle thermometers can be sure students will break them in exactly the way they could have been warned This is because what is not done in planning has a about. way of showing itself in the implementation of planning (teaching) as tension. Tensions are possible in the areas of teacher thinking about planning and teaching, in the amount of energies expended for each phase, in subject matter and repertoire, and in social development and interaction of students.

The findings of this study indicated that teachers' responses to alleviate or eliminate tensions varied. Two teachers' efforts to relieve tensions resulted in negative teaching experiences and no evidence of sustained growth over their units. In contrast, one teacher's experience was positive. Her responses to tensions implemented new thinking and reflection which allowed her to develop alternative ways to assimilate and accommodate (Piaget, 1979) new teaching information into learning experiences, both for her students and herself. In other words, the teacher who was learning her craft in small (micro) increments through the confrontations of tensions in teaching was experiencing growth and development.

Judy's experiences were positive, confronting the tensions in teaching from the first unit and continuing through the second. She used her time and energies to create a learning environment that resulted in student learning over both units. Judy approached tensions of teaching by not denying that they existed.

She used her teaching skills and past experiences to couple them to thinking of teaching and to assimilate and accommodate new information. Bybee and Loucks-Horsley (2001) found that a teacher who knows something needs to be done does not necessarily know how to do it. It was obvious that Judy's lack of subject matter knowledge would impact what she would and could do. Tensions awakened Judy's thinking (Cornet et al, 1990; Jungwirth, 1989, 1990) and allowed her to use subject knowledge and pedagogy from other disciplines (reframing) (Munby, 1984; Schon, 1983). Reframing allowed her to bring together past knowledge and teaching repertoire with new science learning. Thus, Judy had adapted for her learning needs and reduced the tensions in thinking and subject matter she was experiencing. Judy's reflections led her to realize (new learning) that she could teach Science by integrating her Art, English and History with Science. In doing so, her confidence and energy was greater, such that her second unit was based on integrated activities. Judy was relieving tensions and learning from them (healthy tensions) by recognizing the needs and searching for answers (Grouws &

Cramer, 1989). Judy also amassed her energies to the task of integrating her subject matter knowledge and pedagogical skills found in other disciplines. Not only was she learning new subject matter, she was learning how to teach it.

Judy maintained a deliberate goal of serving the social developmental needs of her students, as well as her own needs. Judy saw that student needs included learning beyond science. Her solutions and remedies at every opportunity were to incorporate and constructively integrate the students' needs with social interaction. Judy celebrated student differences by recognizing each student and thanking them for their contributions. She asked them to share, interact and discuss with and among their peers, and she demonstrated caring (Noddings, 1992).

Judy's tensions were over her concern that she would be consistent and fair, but she managed these very well. She created solutions to the tensions in teaching that she experienced. There was a causal relationship between Judy's opportunities (new units) to learn and her engagement in action (reflection leading to action). In those opportunities, Judy made adjustments (framing, rethinking, and reframing) to them. Each new teaching day contained the results of yesterday's successful learning, such that Judy was reinforced by student feedback that energized her efforts and maximized her confidence. The observed experiences were very positive and moved Judy in the direction of what Dewey (1938) called an educative process, thus increasing her growth and development (Berliner, 1986; Granott & Praziale, 2002).

Two teachers' reactions to tensions in teaching were negative. In Mary's case, tensions in teaching began with the first unit and continued through the second. The tensions loomed large and were plentiful. Her reactions and subsequent responses to them did not result in positive growth patterns. Mary's tensions stemmed from inadequate thinking and reflection in planning to teach, subject knowledge and teaching methods (repertoire), social development and student interaction, and energy of effort.

Mary's problems with meeting the tensions of teaching began with her planning and her thinking in planning. Her responses to thinking prompts and reflective thinking prompts, created by the tensions of teaching, were denied. She avoided the decisions on planning by accepting the teacher's guides as her lesson plans. No thinking or reflection was involved in placing these materials before the students. She started the units under the assumption that the teacher guides would provide her with everything she needed and that her past teaching experiences (twelve years) would get her through. She did not create or develop new activities. She followed the teacher's guides very faithfully, step-by-step, and refused to make changes when the labs needed changing. Mary explained, "I have a difficult time changing the directions of the textbook," suggesting her thinking was on hold and that some of the

tension was the result of a lack of specific subject matter knowledge and her willingness to make do (Hanney, 1998). V. Rockcastle (personal communication, 1983) noted a similar behavior in middle school teachers, and F. Holmes (personal communication, 1995) noted that elementary teachers stop using science kits when parts of the kit materials are exhausted or lost. The teachers' limited content knowledge and repertoire meant they were without knowledge to make substitutes, and consequently, had no solution to relieve tensions to teach science except to ignore it all together. Mary did not attempt to change to new ways of teaching (Caine & Caine, 1991), but retained the status quo.

Subject matter and teaching repertoire tensions placed Mary in a difficult and tension-demanding position. Despite a science background, Mary was plaqued by having little experience with hands-on activities that were heavy in lab prepping, management and manipulation of materials which demanded a great deal of her time in order to be prepared every day for two periods. Large classes (32 each), facilities that were not equipped for labs and no directives to students in handling science materials were causes for tensions. If or when time became short, tensions increased. Mary chose to ignore the tensions of learning new subject matter and methods, by her continued dependence on the teacher guides and status quo. She continued daily routines that consisted of educationally weak warm-up activities, lecture and other teacher-centered lessons. Mary contended with new materials, with which she just managed to stay ahead of the students. These responses meant her time was full, and she could not develop healthy social and intellectual relationships (Giroux, 1988) with students.

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Mary was assailed by the requirement to learn new subject matter and methods in order to teach both units. Her solution was to rely on the teacher's quide and become more teacher-centered in her teaching. Mary used lecture as the main method of information delivery, which essentially consisted of procedures and directions. Her preparation consisted of reading the directions for a lab from the text. After each lab, a lecture would follow to explain what students should have found, suggesting the possibility that Mary was also learning as she read. Mary's reflections were limited to procedures, rather than new and inventive thought. In one instance, she realized she could cut her set-up time in half by changing her classes to one class per day for two hours, every other day. This allowed students to work on activities continuously and Mary to gain some time for other tasks.

In a sense, Mary's tensions of teaching got the best of her and lead to unhealthy teaching practices. The lack of positive thoughts and a limited teaching repertoire overshadowed any new knowledge or teacher growth. In addition, Mary's confidence and energy was waning. After the last day of the first unit, she commented, with more spirit than she had shown over the past month, "It's over." And she was quick to follow with, "I won't do that . . . again." Mary was referring to the units. Mary's final interview took place several weeks later. She was much more comfortable and less anxious with the researcher. She spoke freely and implied she was aware and accepted that some units do not go well. She mentioned that she did not feel good enough about the units to teach them again. She said, though, that she might narrow the units down. She also commented about the time for preparation and content of the units, "There is just so much to do. It's a wonder that it can be done."

Overall, Mary coped and survived the two units of instruction. She dismissed or ignored the new experiences and tensions with quick fixes. Her energy was exhausted and mired in the demands of large classes and much preparation; consequently, her new experiences were not positive. By not learning from the tensions of teaching, Mary merely moved through the days of teaching, having uneducative experiences (Dewey, 1938) without any development or growth.

The last teacher to be discussed is Pam. Pam's interaction with tensions of planning, thinking, subject matter, energy, and social development were closely connected in her second unit. Pam's first unit had been taught before and presented no noted tensions. Pam's thinking and reflection for the initial planning and preparation of the second unit followed the planning of the first unit and revealed a lot about her response to tensions of teaching.

Pam's content knowledge was the greatest of the three teachers. She was a Science major and had worked twenty years in a related science field. Yet, she too had subject matter and repertoire gaps in the second unit. The second unit had captured her imagination, and she was excited about her new Olympic Unit on Science in Sports. The unit was scheduled at the same time as the Olympics, but she was still preparing and collecting materials. Her tensions in preparation continued during the second unit and were never quite eliminated.

Pam had tensions of learning new subject matter and deciding what and how to present the information to her students. The new subject matter consisted of human anatomy, sports medicine and sports technology. Pam met the tension of subject matter knowledge by reading and making note cards for information she wanted students to know. She met the tension of teaching strategy by being very teacher-centered, with students taking notes, reading and answering questions. This method was typical in the first unit as well.

Pam's concept of teaching was related to her repertoire in teaching science, and it generated tensions. On the first day of unit one, Pam suggested that perhaps the researcher shouldn't observe that day because she wasn't teaching. She said, "The students are only doing independent projects." Evidently, planning a field trip, constantly moving and helping students and discussing aspects of their projects were not the teaching role images she had in mind for a teacher. Rather, it is suggested that Pam defined teaching as transferring information from teacher to students in the classroom, which was how she conducted her classes. Pam's daily lessons consisted of homework and various reading that

lasted most of a period; consequently, her management and class order was very consistent. Pam did one lab investigation for both units. The small number of labs may have been a source of tension, when she was asked about hands-on activities. Pam said she felt labs took too much time and implied that the time was not worth the effort.

Pam encountered tensions in teaching from her expanding elected duties and the expenditure of energy in trying to do everything herself. These tensions of teaching would appear when something interrupted her schedule. Pam's "Tizzy" (see p. 245) is a good example. She found in that situation she could maintain her routine by reading the questions herself rather than providing students with the questions, copies of which could have been made that morning. Her solution was simply a variation of the same theme and did not constitute any change or inventive way of teaching.

Pam's spontaneous nature and concern those students needed to know more than just science created tensions for her. She had built into her homework routine a time whereby she could make contact with every student, though this time never appeared in her plans. She seemed to operate intuitively (Atkinson & Claxton, 2000), talking to students, boys and girls, on many topics. There was something warm and caring about these conversations and students waited their turns. Questioned later, Pam said, "It was a good time to know about my students." She didn't explain more. At other times, she would simply stop whatever she was doing and say something to the class, which might or might not have had a connection to the topic in progress. The social aspects were clear: points on being a good citizen, doing quality work, respecting each other's right to learn, having a quiet classroom to work in, or respecting property and feelings. Pam spoke of caring for self, from taking showers after PE to the importance of Moose hunting regulations. Pam implied these talks were what teaching middle level students was all about. It is suggested that she was referring to student growth in social development and teaching the whole-child, though she never mentioned it in those terms.

Overall, Pam mentioned in her final interview that she was satisfied with the content of the units, but not the organization. These statements created no tensions. She would do what she did again, though she had a concern about the equipment that she had to use. "Improve the equipment," she was implying, and "I do better." It is suggested, too, that despite the learning of new subject matter, there was no growth from the experience. New material does not equal new knowledge and understanding. She read that swimming suits were covered with Teflon, but her answer to a student query, "What is Teflon?" was "It's the stuff that keeps frying pans from sticking." The answer doesn't convey much understanding about Teflon or the process. Pam's tensions of teaching produced a quick fix, simple to do and move on, but did not incur thinking or reflection. Pam had mentioned several times that she did not have time to reflect (Hansen, 1998). Pam's teaching experiences were equivalent to Berliner's "Mere" experiences (1987) and the tensions did not contribute

to her growth and development (Granott & Praziale, 2002) and were not educative (Dewey, 1938; Feiman-Nemser & Buchmann, 1985).

In conclusion, two teachers in this study demonstrated little personal growth and development as the result of teaching two units of instruction. The tensions of teaching, although serving as prompts to learning, were essentially met with quick fixes or simply ignored. The tensions in teaching resulted in negative teaching reactions and reduced their teaching energies and effectiveness. It is noted that both teachers met the science content knowledge maximums (NCATE/NSTA, 1997), suggesting that greater science content knowledge did not help in meeting their tensions in teaching. It also demonstrated that both teachers' repertoire was limited and did not provide them many choices on how to teach. This was especially true since each teacher chose not to do labs or field trips. As teachers said, "Labs take too much time," or "Labs are just too much pandemonium." The opposite is noted by Judy who demonstrated a remarkable amount of growth and development despite not having a science background, but instead, having a great repertoire in several other disciplines and a rich array of teaching strategies. Once the tensions began to prompt her to find solutions, Judy started using reframed strategies from other disciplines with her new science content to develop integrated lessons. The experiences began in the first unit and continued through the second. Judy later indicated that she continued to teach the integrated lessons and would do so for the rest of the year.
It is clear that Judy's growth and development was in response to how she had dealt with the tensions of teaching (Bryan, 1998; Church, 1998; Newman, 1998). Judy was an excellent example of a teacher whose thinking, coupled with her energy and caring (Noddings, 1992), was able teach, learn and grow as the result of her teaching experiences.

Costa and Garmston (1994) declared that teaching is a process. As such, it was an error for this study to have separated the thinking, energy, social development, and content and pedagogy discussions. There is much overlap. The five areas represent the whole of teaching, and there is an inseparable relationship between thoughts and actions of teachers in order to teach effectively. In this regard, experience in teaching is very real, and growth (Granott & Praziale, 2002) can occur as long as teachers are learners and not passive bystanders in their environments.

Each teacher, to some degree, contributed to their own conceptual development by virtue of the fact that tensions initiated potential, new learning experiences. Because of the interaction of students and time, new learning experiences were generated (Fischer & Yan, 2002; Granott & Praziale, 2002). The microgrowth occurred in small intervals (bursts) of development (Granott & Praziale, 2002). A teacher who perceives (implies reflection), offers a smile as an element of a feedback or says, "Thank you, John," after a student answer, can change how students will learn.

Though microgrowth and development may occur over time and teaching, it is not enough to serve all teachers well.

As such, there are no guarantees that teaching experiences and the interaction with tensions will act as positive prompts for every teacher. In fact, the diversity of the teachers in this study demonstrated that responses are more likely to result in negative experiences that do not serve their growth. It suggests that for each teacher who benefits from teaching experiences, there are more who do not.

Implications

Teacher Education

Implications for the education of middle level science teachers, both preservice and inservice, may be drawn from the results of this study. The current reform reports, documents and studies speak to the needs of middle level science teachers. The National Science Education Standards (National Research Council, 1996) and National Certification Association for Teacher Education (1996) declare that (1) beginning middle level science teachers are weak in content and professional knowledge, and (2) professional development remains a pressing need for practicing middle level science teachers. Middle level science teachers are directed to participate in effective professional development that is results-driven, standards-based, and embedded in teachers' daily work (Sparks, 1997; Jackson & Davis, 2000). Middle level science teachers are directed to relate their past experiences and current understanding of students (AAAS, 1990; NRC, 1996). Teachers are also directed to be

responsible for both their professional and personal growth (Feeney, Christensen & Moravcik, 1996).

Nearly every report, document and study places teachers and teaching at the center of what appears to be a state of crisis and declares that something must be done today. This sense of immediacy does not allow that learning is a process, a long journey. Every new school year brings new students and new tensions to the journey.

Middle School Teachers

This study evolved from a study about three middle level science teachers' planning and implementation of planning (teaching) in "practice settings" (Eisner, 1992) to one of teacher growth and development as promoted by tensions of teaching, which illustrates the need for special teaching qualities for middle level teaching. The practice setting is the "place" where the teacher's mind is on "school." A practice setting may be out of the classroom, when a teacher awakens at 2:00 AM thinking of a solution to a teaching problem, or before school, when a teacher is agitated over losing her prep time, or during class, when a teacher is concerned about a student's health. Practice settings were the homes for tension transformations of daily teaching experiences. The outcome of a teacher's solutions to tension, if not just a quick fix, will begin to impact the teacher's growth (micro) and development (micro). The solutions often represent learning and increase one's knowledge to teach. Practice settings, in this study,

suggest that the middle level may warrant a teacher education program specifically geared toward the education of middle level science teachers. The assumption that future middle level science teachers are best prepared in a basic high school program is short-changing their education and should be reevaluated, considering what is known about the differences between middle level and high school students.

Subject Matter Knowledge

Another of the findings of this study has an implication in teacher education and professional development of practicing teachers. The U.S. Secretary of Education report, Meeting the Highly Qualified Teachers' Challenge (2002), concluded that subject matter knowledge is the most important component of teacher effectiveness. It is a fallacy to maintain that simply increasing science content knowledge is adequate for the preparation of effective middle level science teachers. Darling-Hammond & Young (2002) discounted the data provided by Walsh (2001) in the report, suggesting the data were not based on credible research. This study also contradicts the Secretary's report that effective teaching only required more content knowledge. Rather, effective teaching requires the effective integration of teacher thinking and reflecting, subject content knowledge, repertoire, and energy in conjunction with good knowledge of the student.

None of the three teachers in the study were educated to teach the middle level student. Not only did their subject matter knowledge vary, but also teaching repertoire. Science Teacher Education programs may find it worthwhile, particularly for middle level teachers, to learn how middle schools are organized to meet the needs of the students. In this study, the teacher without the science content knowledge was more successful with her students' learning than those with degrees in Science. The Science major was a product of a Master Education program that routinely called for scripted lesson plans and units which consisted of information that is transferred from teacher to student. Her classroom was marked by teacher-centered instruction, which fit a limited teaching repertoire.

The teaching experiences for Judy, Mary and Pam was a trade-off in content knowledge, knowledge of students and knowledge of teaching for middle level science teachers (Jackson & Davis, 2000; NCATE/NMSA, 1999), with no teacher in the study having proficiency in all three areas. The uniqueness of the students (Adams, 1998) in the schools (Jackson & Davis, 2000) and the curriculum (Beane, 1995; Lounsbury, 1991) suggest that more is needed for teaching at the middle level than just more content knowledge.

Teaching Repertoire

One of the findings in this study was that the teachers' repertoire of strategies for teaching science was limited, particularly for teachers who possessed the most science content. The situations in the middle schools in this study found that teachers with science backgrounds had little knowledge of the ways to teach science other than lecture. There was no evidence that two teachers had much experience or use lab investigation, field trips, or demonstrations. Yet, the teacher with a varied background and majors in Art, Language Arts and History was better able to reframe her experiences from other disciplines to fit the teaching of science and learned the strategies of using labs, and demonstration. In contrast, the teachers with science backgrounds only talk about writing and reading skills, rather than practice them, and were unable to reframe from other disciplines.

Practice

Another implication in the professional development of middle level science teachers' programs is the dilemma of getting teachers to think and plan in great detail, yet not be bound to every second of the plan. The results of this study suggest that practicing teachers simply do not plan in the same the way teacher education programs have preservice teachers plan (Brown, 1988; McCutheon, 1980; Yinger 1977). In this study, teachers were found to do much of their planning in their heads, leaving thorough planning to chance. Adequate thinking and anticipation were not included; whereas, preservice teacher education programs often leave nothing to chance, with planning that requires broad thinking and great detail. There is a danger here that can result in a "scripted" document (Ajzen, 1985) that plans for every student motion and minute in the class. Such plans can

develop a sense that this is the way to teach and novice teachers are not prepared for the flexibility needed in teaching. New teachers need to learn how and when to deviate effectively from plans and take advantage of opportunities to capitalize on teachable moments or to creatively alter a plan. A flexible nature suggests these teachers can become opportunistic teachers (Eisner, 1985; Rogers, 1985) in their planning.

Another area implied in the study was the planning of units and activities. Too often a unit is simply the result of a search for activities that are developed into lessons that are "Kind of" connected. The activities are then connected by a large amount of discourse and discussion. Missing from the unit planning is the understanding of the characteristics of a good activity or how to create one. A more fundamental process that contains high development potential and would involve changes in planning and in the process of teaching is Kelly's (2002) "Lesson study" approach in which teachers share in the development of a lesson. Two or more preservice and/or practicing teachers create a lesson together and observe each other teaching the lesson in order to "polish the lesson" for further teaching. The teachers learn to create activities, learn more subject matter, prepare the conditions, provide quality tasks, think of the factors that affect student learning (reflect), and share and work as a team, all characteristics that are beneficial for middle level science teachers.

Another implication for science teacher education programs is planning units of instruction without knowledge of middle level students. In some teacher education programs, units are developed before preservice teachers have had contact with students. Practicing middle school science teachers said knowledge and learning about middle school students was missing from their programs (Scales, 1992). This is not much different from handing the teacher a new textbook to teach. This study suggests, and is concurred by Turning Points (1989 and Jackson and Davis (2000), that developing units in this manner does not include a concern for the middle level students' social development. It suggests the teachers, like some in the study, did not recognize that middle level students have ideas, and can invent and discover the natural world.

A related implication in the education of middle level science teachers is the lack of emphasis on being cognizant of how teaching and learning affect students. Practicing and preservice teachers must learn to look at themselves and their interaction with their students. Howe (1996) found that to "Produce science activities requires teachers to reach into themselves to use what they already know about teaching and about their students in order to apply their new knowledge of science (p. 174)." Smylie and Conyers (1991) suggested that teachers could experience growth if they depend less on outside resources and find solutions by relying on their own knowledge, experience, and expertise. The solutions proposed by Howe (1996), Smylie and Conyers

(1991) bear a resemblance to self-regulation (Silverman & Casazza, 2000) and self-directed learning (Williams-Boyd, Skaggs, & Ayris, 2000) described above. It would be desirable to develop teachers who are highly independent and self-sustaining and are likely to attach much significance to learning in groups, to being cognizant of student social development and to being viable team members in a middle school. One teacher in this study did not use labs or groups as a form of learning; consequently, students did not learn how to work together. Since an aspect of adolescent education is social development (Jackson & Davis, 2000; Turning Points, 1989), learning in active and productive groups serves as a method to meet student needs to interact with their peers. One teacher who used active groups found she accomplished her content and education goals by using students' needs for social development.

An implication for both teacher practice and teacher education is that teachers do not have a working idea of how to integrate subject matter. This implication has a lot to do with how future science teachers have been taught science, their content knowledge and repertoire (see page 290). It is easy to understand how practicing teachers could have a subject matter gap and a limited exposure to a variety teaching strategies. It is the way they have learned and experienced science (McDiarmid, 1993). What may be useful to middle level science teachers are integrated science and method courses that are taught by a team of content and pedagogy people and which are enlivened with the integration

of several disciplines and teaching strategies. Teachers should be able to learn science and to know how to transform it (Ayers & Schubert, 1994; McDiarmid, 1993; Sorenson, 1993). Hampton (1994) suggested that colleges could start by innovatively naming their courses. Physics 200 For Poets was a very popular science course on the Harvard campus, attracting both the poet and the scientist. A basic Chemistry 101 may sound intimidating to the elementary and middle level teacher, whereas the uninviting nature of Chemistry 101 doesn't sound half as bad when renamed Chemistry For the Gourmet Cook. Maybe, this course would attract elementary and middle school teachers, as well as the chemist. A course such as this would suggest the instructor to be an educator who is committed to learning and teaching by an integration of both content areas and is advancing the idea of more than one way of learning.

Only one teacher in the study was able to integrate, and she fell into integration by accident. Her varied background and life experiences led her to integrate activities by combining strategies and methods she knew with new science subject matter. Other teachers had similar opportunities, but could not find integration because they could not leave the safety of the teacher guides or routines. Hawkins (1990) found that many teachers are inexperienced in the art of encouraging, enticing and supporting students in direct investigations.

Teacher Development

The last implication involves growth in practicing and pre-service teachers. This study concluded that teacher growth through teaching experiences is insufficient for most teachers. The simple responses to tensions of teaching are not enough, though growth is possible for some teachers. Gilbert (1994) suggested that teacher development should be an on-going change process that occurs continuously in schools, generated by teachers as part of their self-renewal. To have an on-going change process, practicing teachers must take charge of their own learning and development (Routman, 1996) and plan for development and growth over time. It is clear that in some cases, teachers should have the help of educators, universities, and school districts to realize their self-renewal.

School districts cannot be expected to take a lead in professional development for its teachers. This study found that professional development for teachers does not rate a high priority, despite caring principals in two cases. In the three studied districts, no budgets were available for individual teacher growth and development.

New teachers and rural teachers also face the further constraint of isolation that restrains development. The literature and the communities in this study viewed teachers as belonging in front of the class teaching.

These conditions open opportunities for universities and teacher colleges to take a lead in developing avenues for teachers to be self-directed through collaborations. Research, peer level observations and sharing, parent and student interaction and study group collaborations can assist educators in greater opportunities to learn, grow, and develop as educators. Collaborations could be particularly helpful for rural school teachers who would not have to cope with long distances, weather and cost as detriments to their development as a teacher.

Limitations of the Study

The research in this study was subject to limitations associated with the design, geographical location and time. The three classrooms were observed in middle schools located in different communities and separated by great distances and difficult and unpredictable travel. Time was a factor in traveling from one location to another. Each teacher was located in a different town, accessible only by air or water transportation. Winter travel means that being weather-bound for several days is always a reality. This led directly to the limitation of only three teachers in the study, in that additional teachers would have been in towns further apart and less accessible.

A greater number of teachers could have been selected for the study, but that would have sacrificed the quality of the study by having to shorten observation periods. To select three teachers for observation allowed for extensive observation periods, which included the communities, schools and teachers.

Another potential limitation was the change in procedure of the units from "Regular" and "New" to just "New." The change actually became an asset to the study as it provided greater opportunities to observe completely new units of instruction. Observations of the "New" units was the focus of the study. This provided a greater number of observations of the teachers in similar teaching situations, but with different class groups. As a result, a more indepth and richer data collection was possible and increased the knowledge about the teaching practices of each teacher. The results of the study, however, may not qualify to be generalized to a larger population.

Another limitation of the study was associated with the observations and the amount of good conversation time with the teachers before and after teaching. Conversations proved to be a rich source of data. It would have facilitated conversation had the time between the observations of backto-back classes been longer. So often, a teacher, already short of time, could not take time for conversation and did so only on the go. No sooner had a conversation started than it would be time for a class to begin. In one case, the observations took place in the morning, which presented a window for conversation before the first class and a few minutes between classes, but gave no time after the second In this case, conversations were also generated class. during lunch periods, after school and by e-mail. The better situation in two cases were observations in the afternoon. One teacher's classes were followed by her prep period. This

made the conversations very timely and fresh in the teacher's mind. In the other teacher's case, the classes were the last two periods of the school day and conversations could follow at the end of the last period.

Another limitation arose when the planned interview schedule was to include one interview after each unit of In all cases, the first unit ended on a Friday, instruction. and none of the teachers were accepting interviews at that time. This condition postponed interviewing to later dates, but teachers were starting their new units on the following The decision was made to leave the interview until Monday. the end of the second unit. The first interview was determined not necessary, since the major emphasis of the interview was for data collection associated to the comparison of a regular unit of instruction to the new unit of instruction. There was no need for the interview, because each teacher's first unit of instruction consisted of new subject matter and did not qualify as a taught unit. The change in interviewing resulted in one interview-conversation over both units and was conducted three to seven weeks after the teaching of the last unit. The timing of the interviews was due to the difficulty of fall and winter travel in Alaska. The interview-conversations were one and one-half to two hours in length.

A limitation was the concern about the presence of the researcher, in the classroom and the use of the video and audio taping which may have had an effect on the teachers' practices. To minimize the effects the researcher presented,

the video camera and audio taping were set up several days before the study began to adjust the class and teacher to their presence. The teachers were asked about this in their interviews. None said they were affected by the researcher's presence in the classroom; however, one teacher did ask that the researcher not observe one class when she became upset over losing her prep period. Another teacher mentioned that she was watching her P's and Q's, but could not explain what she meant, "Oh, you know," she said. A third teacher said she was aware of the researcher's presence, sitting and taping in the back of the room, but she often came back during seatwork to talk and to ask guestions.

A potential limitation was the researcher's conception and philosophy on planning, teaching and the sense of what professional development is for teachers, in that it could affect the analysis of data and the focus of the conclusions drawn. The researcher felt that these limitations were kept to a minimum by being very aware of biases and the effect they could have.

Recommendations for Future Research

This study was designed with a research agenda in mind. There are several areas where this study's results could apply to middle level science teachers. Suggestions for future research are to repeat the study by observing more and longer units and expand the data collection method by suggesting that the teacher should become an active collaborator, and scheduling observations such that teacher

and researcher can have time to converse every day. The intent is to increase researcher-teacher opportunities to have conversations and utilize the concept of "critical friend (Hopkins, 1993)."

Another area for future research would be to expand the data collection by the inclusion of teachers in the research process. The teacher-researcher collaboration could be a simultaneous project with each actually looking at what teachers do. If teachers are so disposed to participate in a study of this nature, they may be more disposed to asking questions that are important to them in conversations that would be more open and revealing.

A third area of future research is to follow teacher planning, implementation, and the impact of teacher learning by looking at how such actions impact student achievement and behavior. How are students affected? No studies were found in the literature that looked at the relationship between middle level science teachers' planning, teaching and growth and student achievement.

A fourth area of research might be to repeat the research. The teachers in this research project were extraordinary. They allowed strangers to come into their rooms with the purpose of watching them. In this study, one teacher said, "How can I help you?" The researcher explained the project, and she said, "Okay, when do you want to start?" She was extremely open and helpful. It would be interesting to observe whether practices created and established in the study period have endured. What new practices have been sustained? Have there been any other teaching changes since the study?

A fifth area of future research could be to explore the perplexing question of subject matter knowledge, "How much is enough?" Many science educators and national reports (U.S. Department of Education, 2002) are calling for more content (Cohen & Barnes, 1993; Weir, 1988), while other researchers question whether simply acquiring more courses will provide the depth of knowledge needed (Tyson, 1994; Jackson & Davis, 2000) to teach science. Science educators also question the content issue by suggesting that every teacher needs pedagogical content knowledge (Shulman, 1987). What was seen in this study illustrates that pedagogy and pedagogical content knowledge are important assets in being able to teach effectively. Judy, with a weak science background, but high pedagogical skills and a full understanding of her students, saw students experience success. Her students were able to explain what they knew and understood to each other and to her. It suggests that future research look at how the nature of repertoire in other disciplines could be applied to the teaching of science. For instance, how would new middle level science teachers use writing, history or art in their classes if such skills and techniques were taught in their science methods class?

The last area for more research is to observe the nature of tensions in planning and teaching by the methods developed for studying and understanding microdevelopment (Granott & Parziale, 2002). The intent would be to gain

further knowledge of where and how teacher's growth is impacted by the experiences of dealing with tensions of teaching.

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APPENDICES

Appendix A Informed Consent Form (Teacher)

Dear Middle Level Science Teacher,

My name is Frank L. Holmes, and I am a doctoral student in Science Education at Oregon State University. I would like your participation in my dissertation research. The research concerns the possible connections between teaching and the potential for personal growth and professional development. Such connections are not well understood at this time.

Your participation will require no changes to your normal routines, or doing something out of the ordinary. The goal of the study is to record what teachers do each day in regular teaching of instructional units. I will need to be present in your classroom to observe your teaching of two complete units of instruction during the school year. The units and the times for teaching are your choice. One of the units should be new. Either in content or method used. Each unit may range in length from two to four weeks, or longer. The observations will be every day of the unit, according to your teaching schedule. Should you be teaching more than one class, the same lessons will also be observed.

Video and audio taping each day during the teaching of the units will facilitate data collection for the observations of teaching. Any requirements or safeguards concerning audio or video taping by you or your district will be honored. Your principal will be contacted regarding district guidelines. I will transcribe the audio and video tapes verbatim. Special precautions will be taken to protect the confidentially of the teacher and students. Pseudonyms will be used for names, locations and other potentially identifying characteristics. At the end of the study, the video and audiotapes will be destroyed. During the study, the tapes will be stored under lock and key. Only my major professor, Dr Norman Lederman and I will have access to the tapes.

Other data sources will be requested from you in terms of your lesson plans, schedule, handouts and papers distributed by the school. Should you keep notes of your teaching or maintain a journal, it would be useful if you could share them with me. After you have taught each day, I would like to meet and hear about your teaching, and discuss any questions you may have about the study. It will not be a formal interview, but an opportunity to talk about teaching. There are no preset questions and we will address only those topics you raise. With your permission, I would like to audio tape these conversations. These conversations need not be long, and will depend entirely on your time.

At the conclusion of each unit, we will meet for an unstructured interview. The questions will be open-ended with the aim to talk about the relationship between your teaching and your sense of personal and professional growth during the period of teaching your units. With your permission, I would like to audio tape the interviews. The interview should take about an hour and can take place anywhere that is convenient. Participation is voluntary and you can end your participation at any time without consequences. Questions about the research should be addressed to me (H) (541) 924-9117 or my major professor Dr. Norman Lederman (W) (302) 567-3659. If you have questions about your rights as a research participant, please contact the IRB coordinator, OSU Research Office, (541) 737-3437. You will be given a copy of this consent form.

Your signature below indicates that you have read and understand the procedures described above and give your informed and voluntary consent to participate in this study.

Signature		Position	
Address		- <u> </u>	
Date	Telephone	e-mail	

Dear Principal,

My name is Frank L. Holmes, and I am a doctoral student in Science Education at Oregon State University. I am a retired middle school science teacher from Haines, Alaska.

I am conducting a study on the possible connections between middle level science teaching and the potential of personal growth and professional development in teachers. Middle level science teachers' actions and behaviors are relatively isolated from observation; consequently, there is a need to investigate what goes on in the science classroom and to describe it. Such connections are not well understood at this time.

The study requires the participation of middle level science teachers from grades six to eight. Your teacher,______ has agreed to participate. In doing so, the teacher has agreed to daily observations of her teaching of two instructional units in her classes of the same grade. This will require the presence of the researcher in the teacher's classroom every day during the teaching of the two units. It is estimated that this observation period will be two to four weeks per unit and can occur any time within the school year.

Audio and video taping will facilitate the data collection during observations. I will need your district audio and video taping guidelines, including written notice if permission from parents is or is not required. Letters seeking permission from parents and students to audio and videotape are available. If there are objections, taping will not be done. Be assured that every precaution will be taken to safeguard the confidentially of the teacher, students and school. Pseudonyms will be used for names, locations and other potentially identifying characteristics. At the end of the study, both the video and audio tapes will be destroyed. During the study, the tapes will be stored under lock and key. Only my major professor and I will have access to the tapes.

Other data sources will enhance the study, such as copies of papers generally distributed to students and teachers, and teacher handouts.

A semi-formal interview will follow the teaching of

each unit. The time will be arranged with the teacher. I would like to receive permission to conduct my doctoral research within your school.

I understand the nature and requirements for the researcher to be present in the school and classroom for an extended period of time. Further, I know I can contact the major professor, Dr. Norman Lederman (W) (302) 567-3659 should I have further questions about the research and can also contact the IRB coordinator, OSU Research Office, (541) 737-3437 about our rights concerning the conducting of research. I know our school can withdraw from the research at any time.

_____Position ______ Signature/Date

Address _____ Telephone _____

Appendix C Letter to Student

Dear student,

My name is Frank L. Holmes, and I am a doctoral candidate at Oregon State University in Science Education. I am a retired middle level science teacher from Haines, Alaska. Your science teacher has agreed to participate in my research study. This study is about the connections between teaching and the teacher's personal growth and professional development. Your teacher, by agreeing to be in the study, will allow me to be in your classroom during the teaching of two units of instruction, which could last for several weeks. During this time, I will be observing your teacher teaching and recording it by using an audio tape and video camcorder. It is possible that during the taping of your teacher, you and other students may also be taped. As a result, I seek your parents' and your permission for you to participate in the study. Participation means you will not be asked to do anything out of the ordinary. Random samples of anonymous student work will be requested from the teacher for comparison of their planning. All student names will be removed from the papers before they are given to the researcher. I request permission to use your work, should it be part of the sample.

Your signature below indicates that you have read the agreement and understand that your parents/guardian have given permission for you to participate in the study described above. You give your informed consent to participate in this study. You understand that your participation in this project is voluntary and you have been told that you may stop your participation in this study at any time. If you choose not to participate, it will not affect your grade, treatment or education in any way. Students who have not given permission will not be video or audio taped, and no samples of their work will used. Such students remain responsible for all work and activities assigned by the teacher.

If you have questions regarding this research project, please contact me (541) 924-9117 or my major professor, Dr. Norman Lederman, at (302) 567-3659 at any time. For questions pertaining to your rights as a participant in the study, please contact the IRB Coordinator, OSU Research Office (302) 567-3659. You will receive a copy of this consent form.

	, Date
Signature	
Address	, Telephone

Appendix D Letter to Parents/Guardians

Dear

Your child's science teacher at Middle School will soon be involved in a doctoral dissertation research project. This project is through Oregon State University where I am a doctoral student in Science Education. The focus of my research is the teacher and his/her interaction with profession development and teacher learning. Students are not involve in the study, except indirectly. During the course of the study, which will last several months, it will be necessary to video and audio tape the teacher during classroom sessions. It is possible then that your student will be videotaped at some during the study. As is the rule, when videotapes are transcribed, pseudonyms for students, teacher, community are used. Anonymity and confidentiality of all participants is maintained at all times. Only my major professor and myself will have access to the tapes and transcripts during the analysis. On completion of the study all video and audiotapes will be erased.

If you have any questions or concerns regarding this research project, please contact me (541) 924-9117 or my major professor, Dr. Norm Lederman, at 302 567-3659

Please sign and date the form supplied and ask your child to sign also and return it to their teacher as soon as possible. I truly appreciate your permission to allow me to videotape in the classroom.

Sincerely Yours,

Frank L. Holmes