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"What" and "How" Does a Mentor Teacher Learn During a Secondary Science Teacher Candidate's Internship?

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"WHAT" AND "HOW" DOES A MENTOR TEACHER LEARN DURING A SECONDARY SCIENCE TEACHER CANDIDATE'S INTERNSHIP?

By

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ABSTRACT

"WHAT" AND "HOW" DOES A MENTOR TEACHER LEARN DURING A SECONDARY SCIENCE TEACHER CANDIDATE'S INTERNSHIP?

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Teaching science for understanding is hard work. Not many teachers leave a teacher education program sufficiently prepared to engage in this practice. In fact, many veteran teachers struggle with this complicated task, so effective professional development is needed. One approach that may hold some promise is being a mentor teacher to an intern. To investigate this possibility, the following central question guided this study: "What" and "how" does a secondary science teacher learn about the practices of teaching from the experience of being a mentor teacher for a science intern?

A conceptual framework based on three planes of focus was utilized in this study. These planes are (a) a focus on the larger learning community and context, (b) a focus on the local learning community and activities, and (c) a focus on learners and purposes.

Data were collected on two focus mentor teachers. These data included observations of interactions between the mentor and intern, responses to clarifying questions, interviews with other science teachers, and observations of both the mentor and the intern teaching lessons. Relationships among the characteristics of the context of the school and science department with the mentor teacher's theory of learning and teaching practices and the patterns of practice the mentor used in responding to specific occasions for learning were explored. It was found that these characteristics are related to

five elements of mentor teacher learning: the social environment, resource use, defining tasks, the learning process, and the nature of a satisfactory conclusion.

Two conclusions were made. The first was that remarkably detailed parallels exist among key elements in the context in which a mentor teacher works, the mentor teacher's approaches to teaching and learning, and the mentor's response to occasions for learning during the internship. The second was that differences among mentors in these key elements could account for differences in "what" was learned and "how" it was learned.

Dedicated to

My wife, Lori, who is always there as I pursue my dreams

My mother, who has always believed in me

My father, who continues to be an inspiration to me

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Chapter One: Introduction to This Study

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- Teaching for understanding is hard
- Professional development is needed
- Being a mentor can be a form of professional development
- Need for the study

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- My student teaching experience
- Work as a field instructor
- Research practicum

A Useful Conceptual Framework

- What practices of teaching are the focus of this study?
- Improving practices or learning new practices: Vygotsky's zone of proximal development
- Planes of focus in sociocultural activity
  - A focus on the larger learning community and context
  - A focus on the local learning community and activities
  - A focus on learners and purposes

Research Questions

- The central question
- Research questions

Significance of This Study

Overview of the Rest of the Dissertation

Overview of the Chapter

Teaching science for understanding is difficult work. One conception places it at the intersection among knowledge of content, knowledge of students, and knowledge of pedagogy. Not only is a teacher expected to have a deep understanding of these three separate arenas, but that individual is also asked to be proficient in the connections among them and be able to apply these understandings to classroom situations "in the moment." Along with this knowledge come complex practices.

Not many teachers leave a teacher education program sufficiently prepared to engage in these practices and develop this knowledge on their own. In fact, many veteran teachers struggle with these complicated tasks. Effective professional development is needed if teaching for understanding is the goal. The one-shot workshops that have dominated professional development for years are inadequate in supporting teachers' learning to teach in this manner. More effective means for professional development are beginning to emerge, and many education researchers and school based professional developers are on the lookout for other productive approaches. One approach that may hold some promise is that of being a mentor teacher to an intern. During my experience as a field instructor in my Ph.D. program, I encountered many mentor teachers who claimed that the experience of being a mentor to an intern was a wonderful means of professional development. These teachers asserted that they learned as much from the intern as the intern learned from them about the teaching of science. Thus, the central question of this study is: *"What" and "how" does a secondary science teacher learn about the practices of teaching from the experience of being a mentor teacher for a science intern?*

I have addressed this question by developing case studies of two mentor teachers. Both were experienced teachers, but one had much more experience working as a mentor. They also taught in quite different high schools. A powerful conceptual framework was needed to better understand how these teachers responded to professional development opportunities associated with their work as mentors. Ideas from Vygotsky, Rogoff, Wertsch, and others were combined in a way that helped explore occasions for learning that were a part of the internship. Three planes of focus led directly to the four research questions upon which this study was based: (a) a focus on the larger learning community and context, (b) a focus on the local learning community and activities, and (c) a focus on learners and purposes. These planes of focus were also used to organize data collection and data analysis.

Rationale for the Study

Teaching for Understanding Is Hard

Scientific literacy for all Americans is the current rallying cry of the science education reform movement. Documents from this "standards" movement outline what a scientifically literate person should understand and be able to do (American Association for the Advancement of Science, 1990; American Association for the Advancement of Science, 1993; American Association for the Advancement of Science, 1998; National Research Council, 1996). U.S. secondary science students, those students who should be the closest to achieving scientific literacy of all K-12 students, have not fared well when compared to their counterparts from many other countries. According to the Third

International Mathematics and Science Study (National Center for Education Statistics, 1998):

- U.S. twelfth graders performed below the international average and among the lowest scoring of the 21 TIMSS countries on the assessment of science general knowledge.
- The international standing of U.S. students was stronger at the eighth grade than at the twelfth grade in both mathematics and science among the countries that participated in the assessments at both grade levels.
- Performance of U.S. physics students was among the lowest of the 16 countries that administered the physics assessment.

Closer to home in Michigan, MEAP data show that for eleventh grade students in 1999, only 51% of the more than 80,000 students statewide met or exceeded state standards (Michigan Department of Education, 1999). What may be even more troubling is that 19.7% of Michigan eleventh grade students did so poorly that they were "unendorsed" in science by the Department of Education. "Science for all" may be the rallying point for this science education reform movement, but the evidence shows that we are a long way from making this a reality.

Although there may be many reasons for these poor assessment results, one is undoubtedly how science is taught in American schools. Science educators in this country have made the improvement of student achievement a high priority, and they have identified more effective teaching as an integral part of this priority (U.S. Department of Education, 1993). The typical science teaching practices of many U.S. teachers are not adequate to help students understand science concepts and theories in

rich and flexible ways (NCES, 2000; NRC, 1996). Students are not asked to take an active role in their learning in many science classrooms. Students need opportunities (a) to engage with the material in ways that incorporate their prior scientific understandings, (b) that allow them to explore many different phenomena and look for patterns in a real-world context, and (c) that allow them to construct new and more sophisticated understandings through interactions with the materials and their classmates and instructors (AAAS, 1990; AAAS, 1993; AAAS, 1998; NRC, 1996). However, there is abundant evidence that most science teachers do not have the knowledge and skills they need to teach in these ways (AAAS, 1998; Horizon Research, Inc., 2002a; Horizon Research, Inc., 2002b).

Professional Development Is Needed

One formulation of the knowledge associated with teaching science for understanding places it at the intersection among knowledge of content, knowledge of students, and knowledge of pedagogy (Anderson, 2001). Not only is a teacher expected to have a deep understanding of these three separate arenas, but that individual is also asked to be proficient in the connections among them (Barnett & Hodson, 2001) and be able to apply these understandings to classroom situations "in the moment" (Schon, 1983). Along with this knowledge come complex practices. A teacher must be proficient in using a teaching cycle (such as planning, teaching, assessment, and reflection) and a learning cycle (such as establishing the problem, modeling, coaching, fading, and maintenance).

Not many teachers leave a teacher education program sufficiently prepared to engage in these practices and develop this knowledge on their own (Yager & Penick,

1990). According to Anderson and Mitchener (1994), much of the important teacher education must occur in the school setting with teachers who are well past the stage of initial job survival. Only these teachers have the mental space to reflect on their work in deep ways, but even many veteran teachers struggle with the sophisticated tasks associated with teaching science for understanding (Davis, 2003). The content can be complicated, the relationships among concepts complex, and effective ways of engaging students elusive. The conceptual burdens on teachers include changing the image of what science is, changing the nature of instruction, changing the teacher's role in the classroom, and changing the manner in which planning takes place (Foster, 1997). However, it is an approach such as teaching for understanding that is needed if students are to comprehend powerful scientific ideas. Complicating matters are teachers who believe they are teaching according to the ideas put forth in the reform documents, but in actuality are teaching quite traditionally (Cohen, 1990; King, Shumow, & Lietz, 2001).

Given that teaching science for understanding is a difficult task even for well-qualified teachers, professional development plays a very important role (Loucks-Horsley et al., 1998). Unfortunately, some common forms of professional development are ineffective, in particular short-term in-service workshops (Lampert, 1988; Mosenthal & Ball, 1992). According to Lieberman (1996), teachers' definitions of the problems of practice have often been neglected, professional development opportunities have often ignored the critical importance of the context within which teachers work, and time for inventing as well as consuming new knowledge has often been absent. In addition, Ball and Cohen (1999) suggest that traditional professional development efforts lack consistency and coherence; there is a need for serious, sustained learning of curriculum,

students, and teaching. Forms of professional development that are neither ineffective nor prohibitively expensive are needed.

Being a Mentor Can Be a Form of Professional Development

Being a mentor teacher is related to current ideas put forth concerning effective professional development. For example, Harty and Enochs (1985) recommended that in-service programs reflect the involvement of teachers in all aspects including the needs assessment, planning, designing, and implementing processes and that professional development provide diverse, flexible offerings that address the current concerns of the practitioner and can be readily utilized in the classroom. These elements of professional development exist in the mentoring experience since a mentor can plan and determine what is paid attention to during the interactions with an intern, and these interactions take place primarily in the mentor's classroom. Lockwood (1998) noted that a compelling argument can be made for substantive, provocative professional development that treats teachers as active learners in their own classrooms as being crucial if students are to improve both the content and quality of what they learn.

In addition, Garet et al. (2001) found that the form of the activity; the collective participation of teachers from the same school, grade, or subject; and the duration of the activity significantly affected teacher learning. Being a mentor means that the form of the activity is flexible and can be best fit to the needs of the mentor teacher. It means that the mentor is working with not only a teacher from his or her own subject area, but also an individual who is working in his or her own classroom with intimate knowledge of the practices that take place and the students involved. It also means that the mentor teacher will be working with this knowledgeable intern for most of the academic year, much

longer than many traditional forms of professional development. Thus, being a mentor to an intern incorporates many aspects of effective professional development experiences.

Two major types of learning are possible for teachers working as mentors. The first concerns learning about being a mentor. As a result of the year-long interaction with an intern and discussions with field instructors, other mentor teachers, university personnel, etc., the mentor teacher has many opportunities to learn more about and practice the various aspects of being a mentor (Koballa, Kemp, Coleman, & Keys, 1999). The second category deals with enhancing teaching practices. As a result of working with an intern and other individuals associated with the internship who may have new ideas about teaching, the mentor teacher may find ways of enhancing his or her own teaching practices. This study focuses on the second of these categories due to its potentially close relationship with teaching science for understanding.

Being a mentor has the potential to create a situation where a science teacher can learn new teaching practices that would help students learn with understanding. Being a mentor teacher involves interactions with individuals (including both the teacher candidates that mentors work with and representatives of teacher education programs) who tend to be well-versed in not only the subject matter content of science, but also in standards-based teaching strategies. The mentor teacher's learning takes place in her or his own classroom where she or he can experiment with new teaching strategies in a familiar environment with well-known students. Since this is a self-directed approach, the progression of the learning takes into account the mentor's existing knowledge, attitudes, and behaviors, which have not been a large enough part of traditional forms of professional development (van Driel, Beijaard, & Verloop, 2001). The potentially intense

relationship with an intern over an extended period of time might enhance the quantity and quality of new teaching practices.

Need for the Study

Some evidence exists that being a mentor teacher might be an effective means for enhancing teaching practices (Clinard et al., 1995; Tatel, 1993; Wilson, 1996). At the very least, it deserves some further attention. A systematic investigation of the activities in which the mentor teacher engages that foster learning about teaching practices is needed. It would be helpful to know which elements of a teaching practice are addressed during the internship and how a mentor teacher learns new ideas, strategies, and skills. Determining these things would assist university and school-based personnel in making decisions about the internship that would benefit both the intern and the mentor teacher with respect to their learning about teaching. The findings from these data also have the potential to not only influence how mentor teachers view their role in the internship, but also help us to better understand teacher learning in the school setting.

Personal Experiences Leading Up to My Dissertation Work

In the previous section, a rationale for this study was presented based on the learning needs of students. In addition to this rationale, there is also a personal side to this research study. I have experienced firsthand many of the issues related to mentor teacher learning.

My Student Teaching Experience

During my senior year of high school, I decided to become a high school science teacher. I loved chemistry, and I loved interacting with others, so this decision seemed to incorporate two of my deep interests. I felt that I received a solid interdisciplinary

education during my undergraduate years. I entered my semester of student teaching with many ideas about how to get to know my students and how to assess their understandings of science concepts. However, understanding the pedagogy of science was an area in which I needed more assistance. My prior experience in teaching consisted primarily of tutoring students individually. I wanted to explore a variety of teaching strategies.

Unfortunately, my mentor teacher[1] was near retirement and seemed to feel that having a student teacher was an easy way to spend his semester. He rarely observed my teaching. In fact, he watched me teach two lessons, a total of 90 minutes, from January 4 - May 20. The few times we did work together to plan a lesson were rich and interesting, but they occurred infrequently. A couple of the students told me he was convinced that I was doing a good job since no one complained about me. Thus, he did not feel the need to be in the classroom when I taught. These students also told me that I should take this as a great compliment since he cared so deeply about his students and their learning. Being young, I did indeed feel complimented. However, I now realize that I was denied his knowledge and skills associated with teaching chemistry and physics. I also feel that I had some ideas about teaching that I wanted to "try-out" on an experienced teacher. It was a situation where each of us could have benefited from working with each other. Yet, little happened due to our lack of interaction.

Work as a Field Instructor

One of the assistantships I had during my first two years as a Ph.D. student was that of secondary science field instructor. Either before, during, or after each intern's lesson, I was able to talk with his or her mentor teacher. We discussed many aspects of

[1] In this study, a mentor teacher is defined as the individual who works with a student teacher or intern during the final stage of a teacher candidate's preparation. It is in the mentor teacher's classroom where the student teacher or intern is placed to gain teaching experience.

the intern's progression in learning to teach. We also discussed the impact this experience was having on the mentor teacher. On many occasions I found that each of the mentor teachers claimed that having an intern in his or her classroom was a great form of professional development. Most mentor teachers said that they learned not only about how to be a better mentor, but also about how to be a better science teacher.

Many times the mentor teacher and the intern claimed that they worked together on projects and activities in the classroom. Many of these projects and activities concerned the intersection of students, pedagogy, and science content. Since teaching for understanding is a goal of the secondary science teacher education program and since interactions that were absent from my student teaching experience were occurring during these internships, I was drawn to questions of "what" and "how" the mentor teachers were learning about science teaching from the experience of being a mentor. These questions led to the focus of my research practicum.

Research Practicum

My research practicum became a pilot study for this dissertation. I interviewed and observed three secondary science mentor teachers in three different schools. The findings led me to believe that there is much to explore in the area of mentor teacher learning as a form of professional development. My research practicum showed that some teachers have found the experience of being a mentor teacher to be a very effective form of professional development. In particular, one teacher, Louis Bishop[2], claimed the following:

[2] All names of individuals and schools in this document are pseudonyms.

- Interns stimulate mentors to think of new approaches to curriculum, planning, classroom management, organization of room, ways to create a more positive learning environment for students, and assessment.
- Interns offer a fresh approach and tons of collaboration about all of the above.
- Interns bring some new content knowledge to the mentors, especially teachers who have been away from institutions of higher learning for a while.
- Interns bring some fresh ideas for classroom activities to mentors, as well as any new education philosophies/techniques learned at the university.

The findings from my research practicum provided some insights into "what" a science teacher could learn from the experience of being a mentor. I was intrigued by the question of "how" a teacher learns from the experience of being a mentor to an intern that would lead to such interesting outcomes as those put forth by Louis Bishop. Unfortunately, the methodology employed during my research practicum did not provide the depth or richness of data needed to investigate the complex issues related to how an individual learns from an experience. Using the literature associated with some of my coursework and one of my research assistantships as a starting point, I began to delve into the research surrounding teaching for understanding, professional development, teachers learning from their practice, and sociocultural learning theory. Each of these areas of literature seemed to have the potential to inform my approach to investigating how a teacher could learn from the experience of being a mentor to an intern. The findings from my literature review were meshed with my experiences as a science teacher and field instructor to produce the following conceptual framework.

A Useful Conceptual Framework

What Practices of Teaching Are the Focus of This Study?

Since this study is concerned with "what" and "how" a mentor teacher may learn to enhance his or her own teaching practices from the experience of being a mentor teacher, outlining the practices of teaching that could be improved is a logical place to begin. However, producing an exhaustive list is almost a nearly impossible task since the practices of teaching associated with teaching for understanding are great in number and complexity. In addition, to bound this study and to examine the desired teaching practices in some depth, just a few may be chosen. The teaching cycle of planning, teaching, assessment, and reflection was central to the conception of teaching for understanding used in this study. Since many of the activities of teaching in this manner are incorporated in the teaching cycle, it was a good place to begin in developing an understanding of how an individual learns about this approach to teaching science.

In this study the activities in the following set of practices are being referred to when the topic of "what" a science teacher can learn from being a mentor to an intern is discussed. This set includes, but is not limited to:

Planning (for both individual lessons and for units)

- Clarifying the goals and objectives
- Finding and evaluating teaching resources
- Selecting content and examples
- Selecting teaching strategies and activities
- Selecting assessment strategies
- Planning for expected student activity

Using teaching strategies

- Determining the level of responsiveness to students' needs and desires
- Implementing strategies that the teacher believes are useful
- Determining the level of interaction between teacher and students and among students

Conducting assessments (both formally and informally including embedded assessment)

- Understanding students' thinking about science
- Assigning grades
- Providing feedback to the teacher concerning his or her teaching performance

Reflecting on one's own performance

- Evaluating the success of teaching
- Generating ideas and plans for improvement
- Generating questions or problems for future work

Improving Practices or Learning New Practices: Vygotsky's Zone of Proximal Development

If the practices outlined above represent "what" a teacher might learn from the experience of being a mentor teacher, then a way of examining "how" these practices are learned was a logical next step.

I found the concept of the zone of proximal development (ZPD) put forth by Vygotsky to have useful elements for thinking about the question of "how" mentor teachers learn about these practices. Briefly, the zone of proximal development is the

distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under the guidance of a master, or in collaboration with more capable peers (Vygotsky, 1978).

> The zone of proximal development embodies a concept of readiness to learn that emphasizes upper levels of competence. These upper boundaries are not immutable, however, but constantly changing with the learner's increasing independent competence. What a child can perform today with assistance she will be able to perform tomorrow independently, thus preparing her for entry into a new and more demanding collaboration. These functions could be called the "buds," rather than the fruits of development. The actual developmental level characterizes mental development retrospectively, while the zone of proximal development characterizes mental development prospectively (pp. 86-87).

Although in this passage Vygotsky is discussing learning in children, I believe the same principles of the zone of proximal development apply to learning in adulthood. Figure 1 is my take on how this idea transfers to being represented as a diagram.

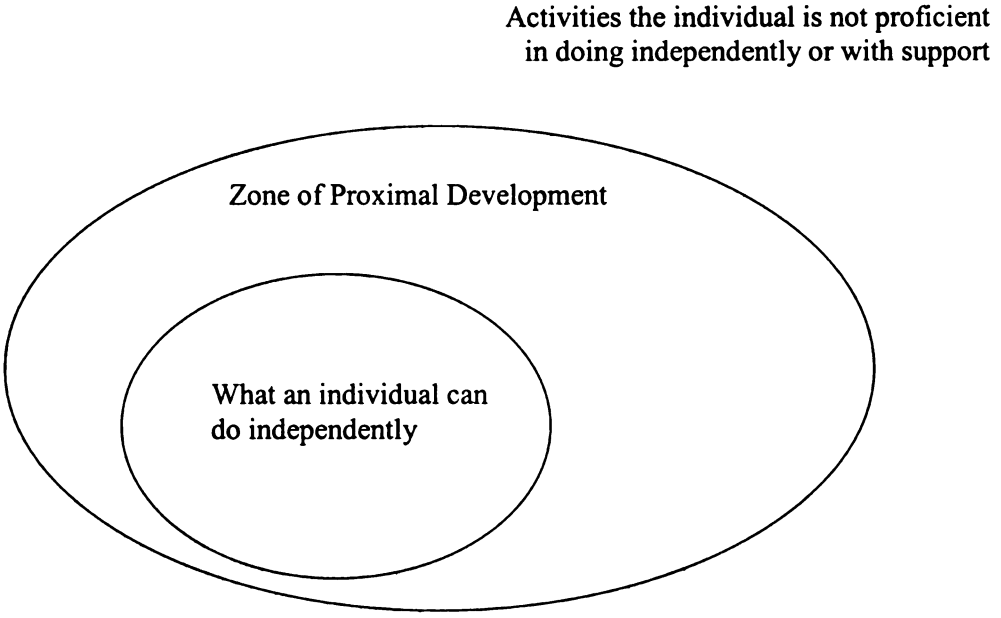


Figure 1. My conceptualization of Vygotsky's Zone of Proximal Development.

The inner ellipse represents activities that an individual can do independently. The individual understands the means by which to do the activity and is familiar with and can utilize the appropriate tools in accomplishing the task. The zone of proximal development is a region representing the activities an individual can do with social and material support. Finally, everything else is located in a region outside the zone of proximal development that is defined by activities the individual cannot participate in meaningfully, even with social and material support.

There are two features to note in Figure 1. The first is that the zone of proximal development surrounds what the individual can do independently. However, the width of the zone is not equal on all sides of the individual's knowledge. This represents my idea

that the learning that is needed to meaningfully participate in new activities is not the same in all cases, both quantitatively and qualitatively. For example, I am currently learning how to write an acceptable dissertation. This work is complex and involves many different activities and the input of a variety of individuals over an extended period of time. This activity would be found in a wider area of the zone than, for example, when I learned how to find my books for the pro-seminar course before my first semester in the doctoral program.

The second feature to note in this diagram is that the region "Activities the individual is not proficient in doing independently or with support" is boundless. This aligns with my belief that the universe of understanding is without end. What we know, believe, and are capable of doing is infinitesimally small compared to both our potential and what could be known.

The zone of proximal development consists of activities. Thus, the ZPD is a place where knowledge, beliefs, and skills are socially constructed. Here the individual experiences and reflects upon activities in which she or he engages with others and/or with tools that are utilized in the activity. Through these activities, the individual learns patterns of practice that help him or her engage in other activities that are deemed desirable or necessary by the individual and/or the community in which she or he is a member. One aspect of this conceptual framework of teacher learning is based on Kenneth Strike's idea that it is not enough to just have experiences, but that more learning is derived from reflecting on an experience than is derived from the experience itself (Posner, 1996).

Depending upon the practice of teaching in which the mentor teacher is engaged, the zone of proximal development could include activities associated with, just to name a few, (a) the mentor teacher's interactions with the intern, field instructor, other mentor teachers, and MSU course instructors; (b) artifacts produced for the internship (e.g., intern's course documents, mentor teacher handbook, etc.); or (c) books and other materials read during time freed up during the school day due to the intern teaching classes.

The goal of using the ZPD to investigate mentor teacher learning is similar to the goal of using a sociocultural approach in many situations: "to explicate the relationships between human action, on the one hand, and the cultural, institutional, and historical situations in which this action occurs, on the other" (Wertsch, del Rio, & Alvarez, 1995, p. 11). Human action may be external as well as internal, and it may be carried out by groups, both small and large, or by individuals (Wertsch et al., p. 10).

Planes of Focus in Sociocultural Activity

The zone of proximal development is a useful tool in thinking about an individual's learning. It provides a way of thinking about the territory between what an individual is able to do, and therefore understands, and what she or he is not capable of doing. It examines the ways in which supports help to scaffold this territory for the learner, primarily by investigating the activities that are included in the ZPD. These activities are influenced by, and influence, the larger learning community or context in which they take place; the local learning community, primarily the interpersonal interactions among the individuals and tools involved in the activities; and the learners themselves and the purposes they bring to the activities.

The use of "activity" as the unit of analysis allowed for a formulation of the relation between the individual and the social and cultural environments in which each was inherently involved in the others' definition. None of these existed separately. Barbara Rogoff's (1990) approach to observing sociocultural activity was helpful here (see also Rogoff & Lave, 1999). She proposes using three inseparable, mutually constituting planes comprised of different perspectives on the same activity. At various times, one of these planes becomes the focus of the analysis with the other planes present, but remaining in the background (Wertsch et al., 1995). These planes are linked with personal, interpersonal, and community processes. Rogoff conceives of planes of focus not as separate or as hierarchical, but as simply involving different grains of focus with the whole sociocultural activity. To understand each requires the involvement of the others. "Understanding the processes that become the focus at each plane of analysis - individual, interpersonal, and community/institutional - relies on understanding the processes in the background as well as those in the foreground of analysis" (Wertsch et al., p. 146).

Therefore, using this approach to analyze activities associated with the practices of teaching in the mentor teacher's zone of proximal development required that each plane be foregrounded one at a time while keeping the others in mind. This analysis ultimately examined the activities from three different planes with each highlighting different aspects of the activities occurring in the zone of proximal development. The following is a description of each of these planes.

Plane A: A focus on the larger learning community and context. The first plane focuses on the larger learning community or the context in which the mentor teacher's

ZPD is located. This plane could include: (a) the bureaucratic policies and practices of the school, (b) the material resources available to a teacher, (c) the degree of collaboration among teachers in a department, (d) the involvement of parents' beliefs about education and their perception of their student's academic performance, (e) the culture of the students, (f) norms and expectations of teacher behavior in the classroom and outside the school, and (g) expectations from the teacher education program.

To varying degrees, each of these elements of the institutional context shaped the nature of the activities that were in the mentor teacher's ZPD. Rogoff uses the concept of apprenticeship to describe and explain learning that takes place on this level. This metaphor is used to focus attention on the active roles of newcomers and others in arranging activities and support for developing participation, as well as on the cultural/institutional practices, norms, and goals of the activities to which they contribute (Wertsch et al., p. 143).

A further elaboration of this plane would include the role that organizational resources and the context in which the learner finds her or himself play in acting as supports in the ZPD. In other words, the situation itself may present the means and support for which the learner may engage in participation that leads him or her closer to an expert performance of some activity. For example, a mentor teacher who is working collaboratively with her intern on a project that focuses on student learning and uses resources available within the science department may be learning new pedagogical methods. Thus, this activity is in the mentor teacher's ZPD, and the dialogue with her intern and the utilized resources are acting as supports for learning.

Plane B: A focus on the local learning community and activities. This plane focuses on the local learning community and primarily on the activities that take place in the ZPD. Guided participation is utilized by Rogoff (1990) to describe and explain the interactions among individuals in a learning community. This "stresses the mutual involvement of individuals and their social partners, communicating and coordinating their involvement as they participate in socioculturally structured collective activity" (Wertsch et al., p. 146). This creates a "perspective at how to look at interpersonal engagements and arrangements as they fit in sociocultural processes, to understand learning and development" (Wertsch et al., p. 147). These collective endeavors constitute and transform cultural practices with each successive generation. "Their activity is directed, not random or without purpose; understanding the purposes involved in shared endeavors is an essential aspect of the analysis of guided participation" (Wertsch et al., p. 148).

Wertsch's ideas surrounding "activities" fit well with Rogoff's approach. Wertsch (1991) uses mediation, mediational means, and mediated action to help make sense of what is occurring in the zone of proximal development. He makes four points, and these points lead him to conclude that the unit of analysis is human action or activity:

- Mediation is an active process.
- The introduction of a new cultural tool into this active process of mediation inevitably transforms it.
- Mediation always involves constraint as well as empowerment.

- Cultural tools are shaped by cultural and historical circumstances as well as the kinds of action, and they usually emerge for reasons other than to facilitate many of the kinds of action they end up shaping.

Understanding the relationship between human mental functioning and the cultural, historical, and institutional setting (as described in the previous plane) is one goal of sociocultural research. Human action as the unit of analysis includes both of these aspects. One consequence of taking this perspective is that the very notion of agent comes to be redefined. Instead of assuming that individuals, acting alone, are the agents of actions, the appropriate designation of agent is "individual(s)-operating-with-mediational-means."

Plane C: A focus on learners and purposes. The third plane focuses on learners and their purposes. It centers on the changes that are made in the individual's abilities to participate in future activities, not on the internalization of bits of knowledge and skills a learner accumulates and stores for future use. Rogoff uses the term "participatory appropriation" (or just "appropriation") to refer to "the process by which individuals transform their understanding of and responsibility for activities through their own participation...The basic idea of appropriation is that, through participation, people change and in the process become prepared to engage in subsequent similar activities. By engaging in an activity, participating in its meaning, people necessarily make ongoing contributions (whether in concrete actions or in stretching to understand the actions and ideas of others). Hence, participation is itself the process of appropriation" (Rogoff in Wertsch et. al., p. 150).

Rogoff's concept of participatory appropriation is useful in thinking about the engagement of an individual in an activity in her or his ZPD, but it does not take into account the affective aspects of learning. The participation of an individual in a series of activities over time can lead to some value-laden pre-dispositions or habits of mind that influence future activities. These may form from patterns in the activities that the individual identifies to assist with organizing and understanding the complex events in which individuals take part. Barnes (1992) has described these as "frames." According to Barnes, frames "refer to the clustered set of standard expectations through which all adults organize, not only their knowledge of the world but their behaviour in it. We might call them 'the default settings of our daily lives'" (p. 16). He goes on to define them as value-laden and dynamic.

This concept can also be applied to mentor teacher learning in the ZPD. I believe this to be the case because frames have also been defined as "an outline scheme which, running ahead of experience, defines and guides it" (Shibutani in Ball & Goodson, 1985). Thus, a mentor teacher's frames influence the activities that take place in the ZPD. In particular, teachers' theories of teaching and learning and their teaching practices affect the frames that they bring to opportunities to learn while working as mentors.

Research Questions

The Central Question

The following central question guides this study: *"What" and "how" does a secondary science teacher learn about the practices of teaching from the experience of being a mentor teacher for a science intern?*

In order to investigate this central question more closely, the following research questions were used to guide specific aspects of this study. In particular, the question of *how* mentor teacher learning takes place is complex. Rogoff's planes of sociocultural activity were used to deconstruct this question into issues related to the context, activities, and personal factors associated with an occasion for learning. In this study, an occasion for learning was defined as a situation where resources that have the potential to enhance a teacher's practices related to planning, teaching, assessment, and/or reflection and revision were available. Resources were not only the material resources available (e.g., books, notes, money, time), but also human resources (e.g., ideas, perspectives, prior experiences) and social resources (e.g., collaboration, language, shared sense of purpose).

Research Questions

1. How do the contexts of the school and the teacher education program provide (a) norms, (b) resources, and (c) occasions for learning about the teaching cycle for the focus mentor teacher?

2. How does a focus mentor teacher respond to occasions for learning about the teaching cycle? (For example, co-planning, co-teaching, developing assessments with the intern, reflective dialogue with the field instructor, etc.)

    a) What parts of the teaching cycle are involved (planning, teaching, assessment, and/or reflection)?

    b) What actions are taken? (For example, how do the participants act to support the mentor teacher's learning about the teaching cycle? What role does the focus mentor teacher play during these activities?)

c) What cultural tools or resources are used? How are they used? (For example, lesson or unit plans, teaching tools, student work, etc.)

d) Who are the participants in the activity? How do the perspectives of the co-participants influence these activities?

3. How do personal factors affect the nature and extent of the focus mentor teacher's learning about the teaching cycle?

a) What is the nature of the focus mentor teacher's teaching practices?

b) What "frames" and perceptions play a role in helping the focus mentor teacher make sense of the occasions for learning? In what ways do they play a role?

c) What does the focus mentor teacher hope to learn? What is the nature of the focus mentor teacher's motivation to learn? (For example, what dispositions does the focus mentor teacher possess? What expectations does the focus mentor teacher hold for him or herself as a mentor? How does the focus mentor teacher determine the benefits and costs associated with enhancing (or not enhancing) her or his teaching practices?

4. What learning outcomes develop for the focus mentor teachers?

a) What parts of the teaching cycle do mentors claim to have learned about?

i. Planning

ii. Teaching

iii. Assessment

iv. Reflection

b) How do the learning outcomes become part of the mentor's teaching practices?

In order to adequately address these complicated questions, rich and deep data were required. Thus, there was a need to study a small number of mentor teachers in great detail. Focus mentor teachers were used for this purpose. A focus mentor teacher was a teacher who agreed to open up his or her mentoring practices to a researcher for close inspection. These practices included the interactions between the mentor and his or her intern, observations of the mentor and intern teaching lessons, responding to questions that helped clarify decisions that were made during a lesson or a planning session with an intern, etc.

Significance of This Study

This study is significant to the topic of teacher learning in school settings in several ways. First, it has the potential to show how a change in perspective about the internship from being one where the mentor teacher primarily assists in the intern's progress in learning to teach to one where the mentor teacher and the intern act as co-learners in the classroom can help facilitate the enhancement of teaching practices for both individuals. If this occurs, the benefits to be gained from the internship will be seen as more of a two-way street, instead of a one-way street only benefiting the intern.

Second, this study is a close examination of mentor teacher learning in the school setting. It includes three key aspects of learning (context, activities, and the personal factors of the learner) in its analysis. The findings from this study could inform future professional development activities that take place at a school.

Third, my work addresses the "how" question concerning teacher learning. The studies of mentor teacher learning that have been completed thus far have focused

primarily on "what" a mentor teacher learns and have paid little, if any, attention to "how" a mentor teacher learns from this experience.

Fourth, the vast majority of studies that concern mentor teacher learning have taken place at the elementary level. Therefore, contextual influences on mentor teacher learning such as the policies and procedures of the subject matter department in secondary schools have been under-investigated. My study includes an examination of these influences.

Finally, my study investigates what a mentor teacher pays attention to. This is based on his or her theory of teaching and learning and on his or her teaching practices. Examining the role these personal factors play in learning from the experience of being a mentor is crucial to addressing my research questions.

Overview of the Rest of the Dissertation

The argument that will be developed through the remaining four chapters of this dissertation is that remarkably detailed parallels exist among the context of the school and science department, the mentor's personal factors, and the patterns of practice she or he uses when responding to an occasion for learning. These parallels exist for both focus mentor teachers and are related to five elements of mentor teacher learning: social environment, resource use, defining tasks, the learning process, and the nature of a satisfactory conclusion. In addition, it will be shown that differences in these patterns of practice influence "what" and "how" a mentor teacher learns from an occasion for learning.

To build these arguments, the following chapters will address (a) the methodology that was utilized (Chapter 2), (b) the data and analysis of two focus mentor teachers

(Chapters 3 and 4), and (c) a discussion of the conclusions and implications of this study (Chapter 5). Relevant literature related to the discussions within each chapter will be included within the text. The following is a brief overview of each chapter.

Chapter Two: Methodology

This chapter begins with a description of the methods used in gathering data, including the relationship between individual research questions and the particular data collected to address the question. The chapter also includes a description of the analysis procedures that were used and a discussion of the means by which the data are presented.

Chapter Three: Focus Mentor Teacher Betty Northcutt

Betty has been a mentor to about one dozen interns. She had very interesting personal factors that made her an intriguing individual to study. A key component of her theory of teaching and learning included how to make connections between prior knowledge and new knowledge in her students. Her teaching practices centered around the use of student questions. The context in which she worked was also quite fascinating. The site was a former professional development school and had a committed, professional teaching staff in the sciences. The interactions between this mentor teacher and her intern were focused and purposeful.

Chapter Four: Focus Mentor Teacher Donald McMaster

This was Donald's first experience of being a mentor to an intern. He provided an interesting contrast to Betty. His theory of teaching and learning was built upon students independently "processing" information from resources available in the classroom. His teaching practice revolved around the assigned responsibilities of teachers and students. The school placed great emphasis on students showing respect, displaying responsibility,

and "getting along." Interactions between the mentor teacher and his intern were not always focused, but were purposeful.

Chapter Five: Conclusions and Implications

This chapter summarizes the primary conclusions of this study. Implications of these conclusions on teacher education programs, educational research, and professional development are discussed. This chapter concludes with a discussion of the limitations of this study, questions for future research, and some final thoughts and comments.

Chapter 2: Methodology

Overview of the Chapter

Data Collection

What were the types of data needed to address each research question? How was it determined these were the appropriate types of data?

Description of the more fruitful interactions with the focus mentor teachers

Summary table of data sources and research questions

Selection of focus mentor teachers

Why was it decided to have focus mentor teachers?

Why was it decided to have two focus mentor teachers?

What process was used to select the focus mentor teachers?

Brief description of the two focus mentor teachers

Once data collection began, how, if at all, did the collection procedures change?

Data Analysis

Data Presentation

Brief Summary

Overview of the Chapter

The purpose of this study was to explore "what" and "how" a science teacher learns about the teaching of science from the experience of being a mentor to a secondary science intern. The activities in which a mentor teacher engages (interacting with the intern; planning, teaching, assessing, and reflecting on his or her own teaching as well as the intern's; etc.) were used to examine the means by which a science teacher enhances his or her own teaching practice. The role of the context (in particular, the norms of the school and the mentor teacher's science department and the expectations of the university's teacher education program) and the role of the mentor teacher's personal factors (theory of teaching and learning, nature of their teaching practices) were also investigated.

This study utilized two high school focus mentor teachers, one suburban biology teacher and one urban physics and earth science teacher. Focus mentor teachers were chosen to gain the depth and richness of data needed to address both questions of "what" and "how", but in particular to develop a more sophisticated understanding of "how" a practicing teacher learns from a mentoring experience. The "how" question has been under-investigated in the existing literature. Yet its importance is growing as we better understand the significance of teachers' learning *in* and *from* their own classroom practices as an element of effective professional development and as we continue to examine the role mentoring can play in professional development.

This chapter begins with a description of the data collection methods used including the research questions and the types of data collected to address each one and a

discussion of the selection of the two focus mentor teachers. A description of the data analysis procedures follows. Finally, there is a discussion of the presentation of the data.

Data Collection

Table 1

Summary of the Research Design Using Two Focus Mentor Teachers

Overall questions	Research questions	Data collection method
How	#1 Context, #2 Activities, #3 Personal factors	Observations, interviews, clarifying questions, collection of artifacts
What	#4 Learning outcomes	Observations, interviews, collection of artifacts

Table 1 shows the data collection methods used to address each research question. The collection of artifacts was a straightforward process of gathering the resources (or copies) used and/or created during an occasion for learning. Observations, interviews, and clarifying questions need a little more elaboration.

The non-participant observation technique as described by Krathwohl (1998) was used primarily when observing the mentor or intern teach a lesson. This occurred on a number of occasions, which allowed the observed to develop a level of comfort with my presence in the classroom. Thus, more natural behavior on the part of the mentor or intern was evident after a few observations. In fact, as data collection progressed, I was told that they forgot I was in the room. One argument against using this method of observation as noted in Krathwohl is that the observer is unable to fully appreciate the role of the observed. However, I was able to rely on my prior high school teaching experience to relate to events in the classroom while I was collecting data.

Partially structured interviews (Krathwohl, 1998) were used at the beginning and end of the data collection period to gather data related to the mentor's motivation for learning, any changes in how the mentor viewed his or her learning processes, and to gain a perspective on his or her philosophy about teaching and learning. Open-ended interviews (Patton, 1990) were used periodically to gather data on the mentor's perception of any enhancement in teaching practices.

Closely related to semi-structured interviews are clarifying questions. Similarities exist in their open-endedness and their reliance on the researcher to do more listening than talking. One purpose of clarifying questions is to gain an understanding of an individual's reasoning behind decisions that were made in a prior event, such as an occasion for learning. Many of Seidman's (1998) ideas concerning effective interviews were taken into account when using clarifying questions: follow-up on what the participant says; ask questions when you don't understand; ask to hear more about a subject; explore, don't probe; explore laughter; and follow your hunches. Clarifying questions were based on what transpired during an occasion for learning where more than one path could have been taken by the mentor teacher, and an understanding of why the chosen path was taken is desired. Responses to this type of question elicited the "inner voice" of the participant that related his or her reasoning for actions in activities. This reasoning was an important element of the mentor teacher's personal factors.

What Were the Types of Data Needed to Address Each Research Question? How Was It Determined These Were the Appropriate Types of Data?

In this study, the university from which the intern came had a five-year program in teacher education. After teacher candidates finished a bachelor's degree at the end of

their fourth year, they completed a one-year internship that led to teaching certification. Thus, the intern was placed in the mentor teacher's classroom from August - April of the fifth year. The data in this study were collected during the second term (January - May, 2001)[3].

The following tables list in the first column the four research questions introduced in Chapter One, followed by the types of data that were collected in the second column. The types of data under each sub-heading in the second column (a, b, c, etc.) correspond to the sub-questions in the first column. The text following each table describes the goals or purposes of the question, a brief description of the analysis, and a justification as to why these types of data were well-suited for the particular question.

Table 2

Data Collected to Address the Different Parts of Research Question One

Research question	Data collected
1. How do the contexts of the school and the teacher education program provide (a) norms, (b) resources, and (c) occasions for learning about the teaching cycle for the focus mentor teacher?	a) - Informal discussions with other science teachers (e.g., What, if anything, have you learned about your teaching practice from your work at this school? What do you think makes this learning possible?) - Observing science teacher gatherings (e.g., to note topics of discussion related to the teaching cycle, to note the influential routines and views related to teaching practices)

[3] While the data collection involving both the focus mentor teacher and intern ended with the completion of the internship in April, interviews were conducted during May with the two focus mentor teachers.

Table 2 (cont'd)

Research question	Data collected
	b) - Observations of interactions between focus mentors and others (e.g., observing which resources are available during interactions and observing how, if at all, they are used) - Clarifying questions for focus mentors and others after engaging in an activity (e.g., During this activity, what, if any, resources were helpful in improving your teaching practice? How were they helpful?) c) - Observations of daily activities and interactions involving the focus mentor teacher

Brief discussion of the purpose of the question, the data, and the analysis. The goal of the response to this question was to map out the landscape in which the focus mentor teacher worked and show how that landscape affected her or his activities and learning. This includes rich descriptions of the influence of the school and the teacher education program on the norms that existed, the occasions for learning that were available, and the resources that were accessible to the focus mentor teacher to learn about planning, teaching, assessment, and reflection (the teaching cycle). Close observations (Krathwohl, 1998) of the focus mentor teacher interacting with others provided opportunities to examine the occasions for learning that presented themselves along with an investigation of the resources that were at hand during those occasions. The analysis included an examination of which resources were utilized and how they were utilized and also a discussion of the resources that were available but not utilized. Observations and discussions with other science teachers at the school provided insight

into the norms that existed that influenced teacher learning in the school setting. Factors from these observations and discussions that influenced occasions for learning were noted, and any patterns were looked for that would help explain why some occasions were fruitful while other occasions were not taken advantage of to their fullest extent.

Table 3

Data Collected to Address the Different Parts of Research Question Two

Research question	Data collected
2. How does a focus mentor teacher respond to occasions for learning about the teaching cycle? (e.g., co-planning, co-teaching, developing assessments with the intern, reflective dialogue with the field instructor)	
a) What parts of the teaching cycle are involved (planning, teaching, assessment, and/or reflection)?	a) - Observations of the focus mentors' activities and/or interactions with others
b) What actions are taken? (i.e., How do the participants act to support the mentor teacher's learning about the teaching cycle? What role does the focus mentor teacher play during these activities?)	b) - Observations of interactions between focus mentors and others including an audiotape of the interaction and notes of the activities - Clarifying questions for focus mentors and others after engaging in an activity (e.g., What, if any, areas of your teaching practice are affected by this activity? How are they affected?) - Observations of the mentor teaching a lesson

Table 3 (cont'd)

Research question	Data collected
c) What cultural tools or resources are used? How are they used? (e.g., lesson/unit plans, teaching tools, student work)	c) - Collecting artifacts (or copies) used in the activity - Observations of interactions between focus mentors and others including an audiotape of the interaction and notes of the activities - Observations of the mentor teaching a lesson
d) Who are the participants in the activity? How do the perspectives of the co-participants influence these activities?	d) - Observations of interactions between focus mentors and others including an audiotape of the interaction and notes of the activities - Clarifying questions for focus mentors and others after engaging in an activity (e.g., Did the perspectives of the others influence your thinking about your teaching practices? If so, how?) - Observations of the mentor teaching a lesson

Brief discussion of the purpose of the question, the data, and the analysis. The response to this research question was at the heart of the "how" question in this study. By examining the actions, the use of tools, and the role of the participants who engaged in activities with the focus mentor teacher during an occasion for learning, this analysis provided insight into the ways in which focus mentor teachers learn about the teaching cycle. Direct observation (Evertson & Green, 1986) of these activities provided data on not only what was transpiring, but also what was available (e.g., tools, alternative perspectives, etc.) that were not being utilized. A systematic examination of the observations, responses, and artifacts was conducted, and a storyline was created for each focus mentor teacher by looking for (a) evidence of differences from past teaching

practices; (b) evidence of support for changed practices from the intern, field instructor, teacher education program, etc.; and (c) evidence of uptake of new ideas/practices by the focus mentor teacher in current or future teaching cycles.

Table 4

Data Collected to Address the Different Parts of Research Question Three

Research question	Data collected
3. How do personal factors affect the nature and extent of the focus mentor teacher's learning about the teaching cycle?	
a) What is the nature of the focus mentor teacher's teaching practices?	a) - Observations of focus mentor teaching a lesson - Clarifying questions for focus mentor after teaching the lesson (e.g., Why did you make the following teaching moves...?)
b) What "frames" and perceptions play a role in helping the focus mentor teacher make sense of the occasions for learning? In what ways do they play a role?	b) - Focus mentor interview given at the beginning and end of the data collection period (Appendix A) - Stimulated recall activity focusing on the mentor's decisions by using a teaching artifact or audiotape of an interaction
c) What does the focus mentor teacher hope to learn? What is the nature of the focus mentor teacher's motivation to learn? (i.e., What dispositions does the focus mentor teacher possess? What expectations does the focus mentor teacher hold for him or herself as a mentor? How does the focus mentor teacher determine the benefits/costs associated with enhancing her or his teaching practices (or not enhancing her or his teaching practices)?)	c) - Clarifying questions for focus mentors and others after engaging in an activity (e.g., Why did you spend so much time and effort discussing "x"? What do you believe you learned from this activity?) - Focus mentor interview given at the beginning and end of the data collection period (Appendix A) - Stimulated recall activity focusing on the mentor's decisions by using an artifact or audiotape of an interaction

Brief discussion of the purpose of the question, the data, and the analysis. The response to this research question addressed the focus mentor teacher's orientations influencing her or his learning about the teaching cycle during an occasion for learning. This analysis was needed to complement the analysis from the two previous questions. In other words, what mentors take away from an occasion for learning was influenced by the context (Research question 1) and the nature of the activities during an occasion for learning (Research question 2). The orientation of the focus mentor teacher (this research question) was another important piece in addressing the question of "how" teachers learned from the experience of being a mentor teacher to an intern. Once a collaborative relationship based on trust and rapport was established (Erickson, 1986), data collection techniques were designed to assist the focus mentor teacher in making his or her thought processes visible, primarily through the use of clarifying questions. The analysis looked for underlying beliefs, perceptions, dispositions, and motivations by utilizing within-case displays of the data as described by Miles and Huberman (1994). These were used to describe the focus mentor teacher's "frame" (to borrow Douglas Barnes' term). By combining the visible and personal aspects of the focus mentor teacher into one storyline that was set in the context from the first question, a rich description of how mentor teacher learning occurs was developed. This description included the context and personal background for each focus mentor teacher, an examination of occasions for learning, and a discussion of any learning outcomes.

Table 5

Data Collected to Address the Different Parts of Research Question Four

Research question	Data collected
4. What learning outcomes develop for the focus mentor teachers?	
a) What parts of the teaching cycle do mentors claim to have learned about? -Planning? -Teaching? -Assessment? -Reflection?	a) Clarifying questions for focus mentors and others after engaging in an activity (e.g., What, if any, areas of your teaching practice are affected by this activity?)
b) How do the learning outcomes become part of the mentor's teaching practices?	b) - Clarifying questions for focus mentors and others after engaging in an activity (e.g., How are areas of your teaching practice affected as a result of participating in this activity? What specific changes do you think will take place in your teaching practice?) - Observations of focus mentors planning for, teaching, and evaluating subsequent lessons - Collection of artifacts such as lesson/unit plans, teaching tools, assessment instruments

Brief discussion of the purpose of the question, the data, and the analysis. This research question investigated the "what" question concerning mentor teacher learning during an occasion for learning (i.e., "What" does a secondary science teacher learn from the experience of being a mentor to an intern?). Data that address this question were collected via self-reports from the focus mentor teachers concerning their learning and/or changed teaching practices and through independent evidence from observations. For example, a list was compiled of those teaching practices that the two focus mentor

teachers "agreed" or "strongly agreed" that they learned about during the internship and those teaching practices that the focus mentors discussed after an activity. Relevant ideas from the teacher-learning-in-school-settings literature were utilized to systematically examine the interviews and observations by looking for evidence of what new knowledge, beliefs, and skills were helpful to teachers and evidence of how these new knowledge, beliefs, and skills were used in their teaching practices. In addition, available artifacts from before the internship were compared to artifacts used during the internship, and any differences were noted. The results of these analyses were added to the storylines that were developed to describe and explain the focus mentor teachers' learning.

Description of the More Fruitful Interactions with the Focus Mentor Teachers

Many data collection activities were noted in the previous four tables. There were some activities among those listed that proved to provide more rich and interesting data than others. Therefore, weekly data collection efforts focused more heavily on these interactions. A description of each is provided below.

To address the context research question (Research question 1), it was found that informal discussions with science teachers at each high school provided fruitful and interesting viewpoints about norms, resources, and potential occasions for learning. It was decided toward the end of the data collection period to formalize this component of the data collection by interviewing each science teacher in the building who was currently, or had been, a mentor teacher to an intern. Two overall questions were used to frame the discussion of this semi-structured interview: (a) What, if anything, have you learned about your teaching practice from your work at this school? and (b) What do you think makes this learning possible? All of the current interns at both high schools were

also interviewed to gather their interpretations of the norms and resources available at the school that would assist or hinder a teacher learning from his or her own teaching practice. Furthermore, they were asked about their perception of "what" and "how" their mentor teacher learned from the experience of being their mentor using the group interview technique as described by Fontana and Frey (2000).

To address the activities research question (Research question 2), the interaction thought to provide the richest data did indeed end up doing so. Observing the discussions between the mentor teacher and the intern either during a planning period or before or after school allowed for witnessing the resources used during the planning or evaluation of a lesson and the discourse between the two individuals. During these observations, the conversation was audiotaped, notes were taken, and any artifacts that were either used or created were collected. After the interaction, the mentor teacher was asked clarifying questions such as: (a) What, if any, areas of your teaching practice were affected by this activity? (b) How were they affected? and (c) Did the perspectives of the intern influence your thinking about your teaching practices? If so, how?

To address the personal factors question (Research question 3), it was useful to ask clarifying questions of the mentor teacher that provided the opportunity to make public her or his thought processes. This type of clarifying question was used not only after an interaction with the intern, but also after observing the mentor teacher teach a lesson or interact with a group of students or fellow teachers. Questions such as the following were asked: (a) Why did you make the following teaching moves during this lesson...? (b) Why did you spend so much time and effort discussing "x" with your intern (or with this group of students or teachers)? and (c) What do you believe you learned

from this activity? By making these careful observations and asking proper clarifying questions at the appropriate times, insight was also gained into the practices of teaching that were being influenced by the experience of being a mentor (Research question 4). Thus, the data collection designed to gather information about the "how" question was also informing the "what" question.

Table 6

Summary Table of Data Sources and Research Questions

Data sources	Research questions
Observations of interactions	1b, 1c, 2a, 2b, 2c, 2d
Clarifying questions	1b, 2b, 2d, 3a, 3c, 4a, 4b
Collection of artifacts	2c, 4b
Observation of mentor teaching a lesson	2b, 2c, 2d, 3a, 4b
Stimulated recall activity	3b, 3c
Informal discussions and observations	1a
Focus mentor teacher interview	3b, 3c
Interview: Appendix A	3b, 3c

Even though Table 6 lists a number of data sources, it is important to remember that an *occasion for learning* was the unit of analysis in this study. Many different occasions for learning were observed during the data collection period. A partial list includes:

- Mentor and intern co-planning a lesson

- Mentor and intern developing an assessment together
- Mentor and intern reflecting on a lesson taught that day
- Mentor and field instructor discussing the intern's development in learning to teach for understanding
- Mentor participating in a mentor teacher meeting with other secondary science mentor teachers and MSU instructors where science teaching strategies were discussed
- Mentor using time freed up during the intern's lead teaching period to surf the Internet for resources or read a teaching journal

Four occasions for learning were chosen: Betty's investigation of how to teach mitosis more effectively, Betty's strategy for developing test questions, Donald's use of free time during the internship to develop a teaching strategy for AP physics, and Donald's and his intern's planning of earth science lessons. These four were chosen for a couple of reasons. First, it was my goal to include data and analysis on all parts of the teaching cycle, so that as much as possible could be explored about the enhancement of teaching practices as represented by the teaching cycle. Planning, teaching, and assessment were central to individual occasions for learning in this study, with teaching occupying a central role in two of these occasions due to its importance in what teachers do in the classroom. Reflection and revision were pieces of each of these occasions either due to the teacher's own approach or to my use of clarifying questions after each occasion for learning. Second, each of these four occasions for learning took place over an extended period of time so that multiple visits for data collection could take place. This extended time allowed for increased quantity and quality of data.

Selection of Focus Mentor Teachers

Why was it decided to have focus mentor teachers? If this study concentrated solely on "what" a teacher learns from the experience of being a mentor to a secondary science intern, then a questionnaire combined with an interview of the respondent might have sufficed. However, since the "how" question was posed, a process, in this case a learning process, had to be explored. This meant that time was needed to make careful observations and collect multiple kinds of data and, therefore, the number of teachers involved in the study was small. By selecting a limited number of mentor teachers upon which to focus, rich and deep data were collected that had the potential to shed light on the factors and processes associated with mentor teacher learning.

Why was it decided to have two focus mentor teachers? Studying many mentors would provide a breadth of understanding about mentor teacher learning, but data collection schedules may conflict which wouldn't occur if only one focus mentor was observed. In the end, it was decided that including two mentors in this study provided some definite advantages. By choosing two focus mentors instead of just one, there was the possibility of making some comparisons between their learning experiences. Also, including just one mentor in this study was analogous to putting all eggs in just one basket. A mentor might not be able to continue with the study for some reason after data collection had begun, or even though a particular site looked like a promising place to gather data at the beginning of data collection, for some reason this promise might evaporate. Having two mentors in this study provided some insurance that data would be collected throughout the duration of this study on at least one teacher. Choosing more than two mentors did not seem possible given that data could not be collected in all

places at all times. This was of particular importance since there was the desire to gain a good amount of depth of understanding about the "how" question in this study, and studying many mentors would mean that resources would be spread too thin to adequately address this part of the study.

What process was used to select the focus mentor teachers? There were a few key factors related to the prospective focus mentor teachers that helped in determining who to choose for participation in this study. First, the mentor teacher needed to be willing to participate in this study. This meant opening up his or her classroom for observations and being available to discuss the activities in which she or he engaged to enhance teaching practices. Given this pre-condition, there were two other factors used in the selection process: reflection and experience being a mentor.

The most important of these factors is the degree to which the mentor teacher was reflective and open to discussion. Much of the data collection depended on the mentor teacher being able to describe and explain in some depth her or his reasoning about decisions that were made. In order to do this, the mentor needed to be reflective. In addition, the mentor teacher needed to want to talk about her or his teaching practice in ways that provided access to understanding how and why selected teaching practices were employed. The mentor had to articulate the process by which she or he is learning from the experience of being a mentor teacher as best as possible.

The other factor that was used to determine the focus mentor teachers was the amount of experience the teacher had being a mentor in the university's teacher preparation program. If a teacher had agreed to be a mentor in this program multiple times, this individual must feel some benefit from that role. It might also mean that this

teacher is in his or her mid-career and that she or he has learned some things about teaching practices from previous mentoring experiences. In contrast, a teacher who has not had an intern (or maybe has had only one intern) is new to the experience of being a mentor and is new to taking advantage of learning opportunities present in the internship. In addition, this teacher might be in his or her early career and still working hard at learning to teach. These contrasts were significant and had the potential to create very interesting and complementary storylines of mentor teacher learning.

Likely candidates for participation in this study were nominated by the intern-year instructors (TE 802 instructors). From this list, each mentor was called and a short interview was conducted. After explaining the reason for the call, this interview included these questions:

1. Do you believe that your own teaching practices have been enhanced due to the experience of being a mentor to your intern? If so, which teaching practices?

2. For those teaching practices that you just mentioned, how has this enhancement occurred? What activities have you engaged in with respect to each teaching practice?

The teacher was then asked to respond to the following items:

3. Interactions with my intern and/or others associated with this internship help me to plan better. (i.e., clarifying the goals and objectives, selecting content and examples, selecting teaching strategies and activities, selecting assessment strategies, planning for expected student activity)

Strongly Agree Agree Disagree Strongly Disagree

4. Experiences during the internship help me to develop and implement innovative teaching strategies.

Strongly Agree Agree Disagree Strongly Disagree

5. Experiences during the internship help me to develop and implement innovative types of assessments. (i.e., defining the degree of connection with goals/objectives, creating and using data collection strategies, creating and implementing forms of analysis, determining the methods of using information from the analysis)

Strongly Agree Agree Disagree Strongly Disagree

6. The interactions with my intern and/or others associated with this internship help me to reflect on my own teaching performance.

Strongly Agree Agree Disagree Strongly Disagree

7. Are you interested in participating in a study that examines your learning from the experience of being a mentor?

Based on the responses that were received to these questions, two focus mentor teachers were chosen. Their responses were evaluated based on the degree to which they focused on the teaching cycle components and the depth and richness of their descriptions of the means by which they were enhancing their teaching practices.

Brief description of the two focus mentor teachers. The chosen focus mentor teachers were Ms. Betty Northcutt and Mr, Donald McMaster. Ms. Northcutt taught

biology at a sub-urban school district for 27 years. She was a mentor teacher to about one dozen interns. During the 2000-2001 school year, she was teaching two genetics courses to juniors and seniors at Heisenberg High School, the only high school in this district.

Mr. McMaster had taught at Einstein High School for four years. Before that he taught at another high school in this district for eight years. Although he had hosted teacher candidates during their senior-year course in the past, this was the first time he was acting as a mentor teacher to an intern. During the 2000-2001 school year, he taught two sections of earth-space science to freshmen, two introductory physics classes to juniors and seniors, and one Advanced Placement Physics course to juniors and seniors. Einstein High School was one of three high schools in this urban district.

Once Data Collection Began, How, If at All, Did the Collection Procedures Change?

As data were being collected, hypotheses were created about the focus mentor's learning that were tested in future observations. In this way, the analysis informed future data collection occasions. Evidence of differences from past teaching practices, evidence of support for changed practices through the interactions with the intern, and evidence of uptake of new ideas/practices by the mentor in current or subsequent teaching cycles were looked for. Hypothetical storylines about the supported practices associated with the focus mentor's learning and how these might turn into independent practices were developed.

The storyline was based on the teaching cycle. Individual episodes involving planning, teaching, assessment, or reflection/revision were linked to form a story of how the mentor teacher enhanced his or her practice from these interactions. This storyline included both the visible aspects of the activities in which the focus mentor teacher

engaged and the personal factors that influenced mentor teacher learning. This storyline was set in the context of the focus mentor teacher's work. Thus, data were collected concerning the influence that the school, the science department, and the teacher education program had on mentor teacher learning. These three factors were seen as having the greatest influence due to the milieu of the mentor's work and the background and ideas brought to this setting by the intern. The analysis of these data helped to situate the storyline. The storylines were also situated with respect to other mentor teachers' experiences at the school. Data were collected and analyzed that speak to the variety of ways in which mentor teachers learn. Although the data collected on other mentor teachers was limited compared to the data collected on the focus mentor teachers, it nonetheless provided evidence of other ways in which learning about the teaching cycle occurred during the mentoring experience.

Data Analysis

As was stated in the previous section, preliminary storylines were created while data collection was still occurring. For example, one storyline associated with Betty was related to the purposes of the questions she posed to her intern. It seemed that during their interactions, Betty was carefully considering each question she asked. What were her underlying assumptions and beliefs that led to the particular questions being asked? What purpose did she perceive certain questions having? How did these questions influence their actions during an occasion for learning? In Donald's case, one storyline was centered around the question of: Where was the earth science subject matter knowledge at Einstein High School? The development of these storylines represented the first

analytical pass through the data, looking for emerging themes and patterns. Data collection was modified to address tentative hypotheses associated with these storylines.

Once data collection ended, the data were put into an electronic format. This means that the notes taken during observations were typed, and the audiotapes made during interviews and interactions between the focus mentor teacher and others were partially transcribed. Only those pieces of the tape that were directly related to the research questions were transcribed while the remaining portions of the tapes were summarized.

The conceptual framework was then used to organize the data. Data were categorized based on the three planes of focus (context, activities, and personal factors) and using the research questions. A set of nodes related to these categories was used to code the data (Krathwohl, 1998). These nodes may be found in Appendix B. NUD*IST (Non-numerical Unstructured Data Indexing Searching and Theory building) software was used to assist with the coding. From the different nodes, a more structured storyline was developed for each of the focus mentor teachers. These storylines were created based on data found at the nodes associated with the context, activities, personal factors, and learning outcomes.

During the development of these storylines, I met with my dissertation support group, which consisted of two other Ph.D. students in the teacher education program. We formed this group not only to assist each other with our dissertation work, but also to support each other emotionally through the process of completing our respective degrees. Every other week we met to discuss something one of us wrote, to relate stories of our progress, and to ask questions we had about issues that were arising. When forming the

group, we purposefully did not include other members from our subject matter area so that perspectives from other disciplines could inform our work. We provided feedback to each other about the ideas we were using and about the quality of our writing, and we encouraged one another to "keep going." Virtually all aspects of this data analysis were opened to the scrutiny of my dissertation support group members, and their feedback was very useful in the development of the storylines and, ultimately, the final product.

During this same time, meetings with my dissertation advisor were also taking place on a regular basis. We discussed many of the same things that I discussed with my dissertation support group members. He read many drafts of individual chapters, with his feedback at times providing new insights into analyzing the data and at other times reinforcing my findings from the data. Many of the ideas used in this final product were created and developed during our discussions, and his input was an invaluable part of my work.

The storylines led to a list of commonalities between the two focus mentor teachers. Each was energetic, intelligent, curious, ambitious, involved in many things at their school, articulate about their teaching practice, and espoused constructivist theories of teaching and learning, at least on the surface, that were congruent with MSU's teacher education program and the reform movement. Yet, when looking at what each focus mentor learned, things looked quite different. This led to the puzzle of why the learning outcomes would be so different when the two focus mentor teachers were quite similar.

The storylines, coded data, and three planes of focus (context, activities, and personal factors) were utilized in determining important characteristics of each mentor teacher. (A fuller discussion of these characteristics appears in the data chapters.) Betty's

characteristics that were readily apparent included: (a) creating an atmosphere of mutual trust, sharing ideas, and constructive criticism; (b) a reliance on carefully formulated researchable questions; (c) scaffolded collaborative work on problems and collecting and using empirical data to develop new ideas and strategies; and (d) finding multiple examples or tests of adequate learning and continuing the search for better solutions. Donald's readily apparent characteristics included: (a) a focus on mutual respect and "getting along"; (b) learning about what works through individual active processing of learning materials; and (c) finding acceptable activities and resources that cover the expected content and continuing the search for new resources.

These characteristics were examined closely, and it was noticed that some overlap existed. Betty's creating an atmosphere of mutual trust, sharing ideas, and constructive criticism was very similar to Donald's focus on mutual respect and "getting along" with respect to the social environment each created. Betty's scaffolded collaborative work on problems and collecting and using empirical data to develop new ideas and strategies was very similar to Donald's learning about what works through individual active processing of learning materials with respect to the learning process. Betty's finding multiple examples or tests of adequate learning and continuing the search for better solutions was very similar to Donald's finding acceptable activities and resources that cover the expected content and continuing the search for new resources with respect to the nature of a satisfactory conclusion. Thus, the social environment, the learning process, and the nature of a satisfactory conclusion became *elements* of mentor teacher learning since they were present for each focus mentor teacher and played such prominent roles in the

occasions for learning. Identifying these elements was a product of many discussions with my dissertation advisor.

Betty's reliance on carefully formulated researchable questions did not have an obvious counterpart in the storylines already developed for Donald. Therefore, the data was explored for the ways in which Donald defined the tasks in which he partook. A pattern emerged in which Donald engaged in assigned responsibilities in his interactions with others. Thus, "defining tasks" became another element of mentor teacher learning.

As data collection proceeded, the difference in available resources for each mentor was becoming increasingly obvious. Data was collected noting the material, human, and social resources that were accessible during occasions for learning. Betty located and utilized relevant human and material resources from the abundant supply available to her while Donald relied upon the textbook and himself. Since resources are important to activities, "resource use" became another element of mentor teacher learning.

Data were available to support claims made about these five elements and together they addressed the "how" question posed in this study. The final element, learning outcomes, is related to the "what" question. Betty learned how to address a common misconception about mitosis, and she learned how to make an assessment more effective. Donald learned something about the construction of websites as a teaching strategy.

Thus, the characteristics of both Betty's and Donald's pattern of practice can be related to five elements of mentor teacher learning: the social environment, resource use, defining tasks, the learning process, and the nature of a satisfactory conclusion. It should

be noted that these elements play important roles in not only the mentor teacher's occasions for learning during the internship, but also in their teaching and interactions with students and in their work with department colleagues. A fuller discussion is presented in the data chapters, which leads to the two conclusions of this study:

- Differences in the elements of mentor teacher learning can account for differences in "what" was learned and "how" it was learned
- Remarkably detailed parallels exist among key elements in the context in which a mentor teacher works, the mentor teacher's approaches to teaching and learning, and the mentor's response to occasions for learning during the internship.

Data Presentation

There were at least two ways of presenting the data and the corresponding discussion for this study (Krathwohl, 1998). The first way would be to organize this presentation around the questions of "what" and "how". This would mean that "what" the two mentor teachers learned from their experiences would be described together. The influences of context, activities, and personal factors for the two focus mentor teachers would be compared and contrasted. Likewise, the "how" question would be treated in a similar fashion. However, the richness of the individual mentor teacher's experience might be lost in such an organization. It can be argued that this richness adds much to this study. In addition, separating these two questions into two different chapters would run the risk of losing the interconnectedness of "what" someone learns with the process of "how" the learning takes place (Erickson, 1986). Given this, it was decided to use another means to present the data and its analysis. Two chapters are used to describe and discuss the data. Each one focuses on an individual mentor teacher.

The story of Betty. Betty had been a mentor to about one dozen interns. She had very interesting personal factors that make her an intriguing individual to study. A key component of her theory of teaching and learning included how to help her students make connections between prior knowledge and new knowledge. Her teaching practices centered around the use of student questions. The context in which she worked was also quite fascinating. The site was a former professional development school and had a committed, professional teaching staff in the sciences. The interactions between the mentor teacher and the intern were focused and purposeful.

The story of Donald. This was Donald's first experience of being a mentor to an intern. He provided an interesting contrast to Betty. His theory of teaching and learning was built upon students independently "processing" information from resources available in the classroom. His teaching practice revolved around the assigned responsibilities of teachers and students. The school placed great emphasis on students showing respect, displaying responsibility, and "getting along." Interactions between the mentor teacher and his intern were not always focused, but were purposeful.

By organizing the presentation of the data in this manner, each focus mentor teacher's story can be told in its entirety. This provides the reader with a deep and relatively complete understanding of the focus mentors' experiences. It also allows the reader to see the connection between what was being learning and the processes associated with this learning. Each story was sent to the respective focus mentor teacher for feedback, and the comments were considered. Any errors were corrected.

Brief Summary

This chapter has described the specific research methods and analysis procedures used in this study. The methods of data collection organized around the four research questions were described first. Fruitful data collection events were discussed. It was also shown how these methods were modified based on the development of preliminary storylines for each focus mentor teacher and on associated emergent hypotheses.

A discussion was also included of how the two focus mentor teachers were selected. This was followed by a description of the analysis of the data. Parallels were noted among a mentor teacher's work with colleagues, teaching of students, and their own learning. The characteristics of both Betty's and Donald's pattern of practice can be related to five elements of mentor teacher learning: the social environment, resource use, defining tasks, the learning process, and the nature of a satisfactory conclusion. Finally, a discussion of the means by which the data are presented was provided.

An important goal of this chapter was to clearly show how the research questions (which come directly from the conceptual framework presented in Chapter One), data collection methods, and analysis procedures were coordinated with one another. This coherency among these pieces of the study allowed for rich and interesting data to be collected and analyzed. Let us now turn our attention to these data.

Chapter 3: The Story of Betty Northcutt

Overview of the Chapter

A Focus on the Larger Learning Community and Context: The School, the Science Department, and the Teacher Education Program

- The school
- The science department
- The teacher education program
- Key aspects of the context that will be reflected in the occasions for learning

A Focus on Learners and Purposes: The Effect of Personal Factors

- Betty's philosophies of teaching and student learning
- The nature of Betty's teaching practices: Planning, teaching, assessment, and reflection
- Key aspects of the personal factors that will be reflected in the occasions for learning

A Focus on the Local Learning Community and Activities: Two Occasions for Learning

- The identification of "What" is to be learned
- Occasion one: Developing curriculum during the planning period - The mitosis lab
    - Creating an atmosphere of mutual trust and constructive criticism
    - Reliance on carefully formulated researchable questions
    - Locating and utilizing relevant human and material resources
    - Scaffolded collaborative work on problems
    - Collecting and using empirical data to develop new ideas and strategies
    - Multiple examples and a continuing search for better solutions

Occasion two: Reflective dialogue between Betty and her intern - Developing test questions

Creating an atmosphere of mutual trust and constructive criticism

Locating and utilizing relevant human and material resources

Reliance on carefully formulated researchable questions

Scaffolded collaborative work on problems

Collecting and using empirical data to develop new ideas and strategies

Multiple examples and a continuing search for better solutions

Conclusions

The interrelatedness of the planes

Betty's learning outcomes

Summary of the Chapter

Overview of the Chapter

In Chapter One, the conceptual framework for this study was introduced. A key feature of this framework are the three "planes of focus" - context, personal factors, and activities. These planes are used in this chapter to describe the experience of Betty Northcutt, one of the focus mentor teachers and her work with her intern, Cathy. They are used to help us understand the strategies for learning Betty employed in two occasions for learning during the internship.

This chapter is organized from the broadest plane to the most narrow. A discussion of the context of Heisenberg High School, the science department, and the influence of the university's teacher education program begin this chapter. This will help to set the overall situation where Betty's learning took place along with examining how this context had an influence on Betty's strategy.

The next section (related to the second plane) acts as an introduction to Betty by concentrating on her personal factors. This includes a discussion of her teaching and learning philosophies and a look at her teaching practices. It also includes a discussion of her planning, teaching, assessment, and reflection activities and how her personal factors affected her strategy for learning from an occasion for learning.

The final plane of focus is an analysis of the activities in which Betty engaged and the strategies she employed. Two specific occasions for learning that come from Betty's teaching cycle are presented. The first occasion investigates the creation of new curriculum, a new way to teach mitosis. The second occasion resulted from Betty's planning for a formal assessment and her use of her intern in that preparation.

The conclusion to this chapter examines the interrelatedness of the three planes of focus, and it examines the "what" question in this study. What were Betty's learning outcomes from these occasions for learning? A discussion of the parts of the teaching cycle that were enhanced due to participation in the occasions for learning is presented along with the relationship to the personal factors plane and the context plane.

A Focus on the Larger Learning Community and Context: The School, the Science Department, and the Teacher Education Program

The School

Heisenberg High School was a mid-sized, suburban school located in the central part of a Midwestern state. It housed grades 10-12, and the majority of the students were white. The mission statement of the school emphasized the importance of student learning. The work of the Holmes Group (1986) provided the guiding principles for this professional development site. The goals of the school were to (a) teach for understanding so that students learn for a lifetime, (b) organize the school and its classrooms as a community of learning, (c) hold these ambitious learning goals for everybody's children, (d) teach adults as well as children, (e) make reflection and inquiry a central feature of the school, and (f) invent a new organizational structure for the school.

In keeping with this mission statement, the hallways of the high school contained many posters that focused on student learning. Outside one of the science classrooms were posters on topics such as: the water cycle, recycling, state wetlands, state coastal dunes, state forests, and snakes of the state. Student work from a literature class hung on another wall depicting characters, plots, and themes from selected works such as the

"Lord of the Flies". The front pages of newspapers adorned another hall with articles on careers. The only non-academic poster was located outside the counseling office. It displayed some signs of suicide to watch for in friends - changes of behavior, mood swings, etc.

Administrative policies were not seen as a hindrance by the science department teachers. In fact, "Some of our lack of policy might be a hindrance" (Interview with science department chair, 5/15/2001). At times, teachers were given so much latitude in their decision-making that they did not anticipate the effect of their decisions on other teachers. Some of the science teachers felt that having more policies in place might alleviate some of these instances.

The Science Department

The science department was well equipped. Each classroom had a laboratory that was separate from the lecture/discussion area. Reference books, textbooks, software, computers, laserdisks, materials for demonstrations, and laboratory equipment were readily available. During laboratory activities, there were enough supplies that either each individual student or each pair of students had the required materials. Students were not asked to bring in materials from home. The school supplied what was needed.

Overall, the teachers that were interviewed (over half of the science department) felt that they had the freedom to teach what they wanted, as long as the state and district objectives were covered. One biology teacher said that she thought Betty and Louis "paved the way to the current practices of the science department" (Interview with Lauren, 4/20/2001). This meant that these two individuals' teaching practices and ways of improving their work set the standard for the department. Each was always looking for

ways to improve and, in particular, the questions they asked of themselves and others were cited by teachers in interviews as being models for how they went about improving their own teaching practice. Both Betty and Louis had taught in the district for over twenty five years, so their reputation as effective science teachers was well known.

Lauren also believed that the Professional Development School (PDS) experience helped a lot in terms of professional development. Briefly, a PDS is different from other clinical settings because (a) it is an environment that integrates adult's and children's learning; (b) it is characterized by reciprocity and parity for university and school partners on all issues of practice and policy; and (c) there is simultaneous renewal of the school and the university (Teitel, 1998). Common activities in a PDS setting include those centered around varied forms of initial teacher preparation, opportunities for teachers to engage in continuing professional development by working with university faculty members, efforts to increase all students' learning, and research into teaching and learning for the purpose of improving both (National Council for Accreditation of Teacher Education, 2001). Even though the activities associated with being a PDS had curtailed in recent years, the effects of this experience were still prevalent among the staff's actions.

To examine the context of the science department, Newmann and Associates' (1996) ideas related to professional communities are helpful. These authors claim that a shared sense of purpose, collaboration, a focus on student learning, deprivatized practice, and reflective dialogue are the key elements of a professional community. Of these elements, a focus on student learning and collaboration are the two that were most prevalent in this science department. Collaboration among the faculty on issues related to

student learning was widespread. Every teacher who was interviewed cited at least two recent examples of collaboration among the science department teachers. Examples included improvements to the biology curriculum, work on the tenth grade assessment, finding ways to help low-achieving students perform better on classroom activities, and developing strategies for integrating big ideas in science across biology, chemistry, physics and technology courses.

Collaboration in this department was an outgrowth of reflective dialogue and deprivatized practice. The science curriculum demanded intellectual rigor of both the students and the teachers. Thus, these teachers constantly were looking for new knowledge and practices that could enhance their work. Sharing expertise with one another increased these teachers' competence. As Lauren stated, "I have always asked lots of questions [related to teaching], particularly with biology. Louis and Betty were always willing to provide ideas and stories from their teaching that really helped me with my teaching. I was very grateful and would help them in any way I could with problems they had. Although that didn't happen as often, it still did happen from time to time" (Interview with Lauren, 5/3/2001).

Other forms of collaboration centered around more formalized projects, like the improvements to the laboratory investigations in the sophomore biology curriculum. As Lauren stated, the biology teachers openly shared the strategies they used when student problems arose either with the lab procedure or with conceptual difficulties. Building on their prior relationships, which included trust and mutual respect, the teachers worked together to produce improvements in their teaching.

The science department chairperson organized regular department meetings every 2-3 weeks, and any science teacher could add to the agenda. However, the interviewed teachers all stated that most of the collaboration that took place was not at formal meetings. Each teacher agreed that informal collaboration was much more common and helpful in their teaching and ultimately in student learning. These activities were considered informal either because they were frequent, but short in duration, and/or they were spur-of-the-moment. As Betty put it, "We share a lot and talk on a daily basis. We eat lunch together. This collaboration existed before Heisenberg was a PDS. However, the PDS helped facilitate it" (Interview, 4/17/2001). Since lunch was a time when most science teachers were in the same location, it became a reliable time and place to ask questions or get help with an issue that had developed in the classroom.

Teachers felt comfortable approaching each other with problems or questions at any time. As one of the chemistry and biology teachers put it, "I don't know what I would say to a teacher who said, 'I am not willing to ask those questions' because the nature of the atmosphere here is very open. I guess I would just say to somebody who said that, 'Everybody's been there. Everybody struggles with how to do this and what to teach.' We don't need to reinvent the wheel. We don't need to re-do all that work. If somebody else has done it, you can benefit from their experience and ask for that help" (Interview with Marianne, 5/3/2001). Noteworthy in quotes like this is the feeling that every science teacher is looking to improve his or her teaching practice, so everyone is asking questions of others. In addition, the need for improvements is constant, so time should not be wasted working on something that someone else has already put time and effort into. E-

mail and dropping things off in another teacher's mailbox were common forms of communication when working on collaborative projects.

What was it that necessitated this need for sharing and focusing on student learning? The science department chairperson responded, "We have a need to be better teachers. Perhaps that necessitates the need to, 'Well, how did you do this because I don't like the way it turned out? What can I do to make this better? How can I improve?' or 'I heard your students talking to my students. They were saying this, that, and the other thing. You know the internet of students. What is it you did? How can I do this?' or 'I tried that same experiment. It didn't quite work. Why?' We feel the need to share and this adds to the openness" (Interview with Darrell, 5/15/2001).

One example of sharing and collaboration that occurred during the spring, 2001 semester centered around a dinosaur activity. Members of the science department had been wrestling with the question of "What opportunities are available in the science curriculum to assist with the learning needs of low-achieving students?" This represented a researchable question that each member of the department took on. Darrell, the department chairperson, had recently attended the National Science Teachers Association annual meeting. While he was there, he attended a pre-session on helping science teachers look for opportunities in the curriculum to assist in special needs students' learning. One of the activities in this session concerned evolution. It depicted the bones of a dinosaur fossil that were found, and the goal was to put the pieces together to form the skeleton. It was not evident where one of the bones fit with the others, except if you thought of it as a winged animal. Darrell brought the handouts from this session back and shared them with Lauren, one of the biology teachers. He thought that she might be able

to use this activity in her class. She did use it, as did other teachers who teach evolution. The results of its use in the various classrooms were then shared among the biology teachers and improvements for the next time evolution was taught were considered.

When asked why he bothered to gather information about an activity that he was not going to use in his own chemistry classroom and share it with others, Darrell replied, "That level of expectation of science success is here. We want our other science teachers to succeed, so we are going to help each other. We all want our students to succeed in science. Most of us realize that science is not the end of it. It is just a tool to be successful in life. Problem solving is a big part of this. I am not in the job to create chemists. I'm in the job to prepare science students to move on to whatever is next. That's the bigger sense of what we're here for." (Interview, 5/15/2001).

Teachers helping one another locate resources and sharing these resources is an aspect of departments and/or schools where a professional community exists and a high degree of importance is placed on student learning (Gamoran et al., 2003; Newmann & Associates, 1996). The subject matter culture can also support the development of professional communities where student learning plays a central role. Cohen, McLaughlin, and Talbert (1993) describe the traditions of content and pedagogy (the "stuff" of teaching), the domains of educational policies and politics, and the loci for discourse communities as being important features of a subject matter culture that can either enhance or constrain teachers' work with helping students learn with understanding. Given the rapid advances in the sciences, it becomes even more important for teachers to share with one another new resources that are located and discuss ways in

which new scientific ideas can be incorporated into the curriculum so that students can develop robust understandings of important concepts.

In a meeting where the science department interns at Heisenberg High School were interviewed, each declared she saw evidence of a focus on student learning coming from the science teachers. Investigations, hands-on activities, and inquiry-based units were all a part of the mentors' teaching observed by the interns, and they saw a definite emphasis on having students link new knowledge to prior knowledge during their mentors' lessons. The interns believed the science teachers wanted to improve how they teach. Sharing information about how a unit or lesson was taught and the development of student understanding was seen by teachers and interns alike as a more efficient means to change the curriculum than working by oneself since ideas were tried multiple times in a year and by different teachers with different sets of students. The interns claimed that the science faculty members had the personalities of wanting to be better teachers and showing that they cared about students (Notes from a meeting with interns, 4/20/2001). The whole atmosphere of the school was very proactive towards professional development. Teachers had Wednesday morning time[4] to collaborate, and they had a number of opportunities for professional development both during the school year and the summer.

Lest we think that all is well in this science department, there were tensions among the faculty members. Each individual teacher held his or her strong beliefs about the education process. These beliefs did not always mesh with the beliefs held by other

[4] When the activities of being a PDS were in full-swing, a portion of Wednesday mornings was set aside for professional development. Classes would begin later in the morning. This model was still employed at Heisenberg High School even though the PDS efforts had declined. This is due, at least in part, to the teachers on-going belief that this time was needed to work on their teaching practices and to find ways of improving student learning.

science teachers. One such tension surfaced over the approach to teaching biology. The best way to affect student learning was at the center of a debate between at least one biology teacher and other biology teachers. For a number of years, cell biology had been a one semester course in which all sophomores enrolled. Students were then given the choice of taking zoology, botany, physiology, or genetics to complete their biological sciences study. Holly, one of the biology teachers, believed that all sophomores should have a year-long course in biology, and she based her argument on the students' learning of the state objectives. She believed that concepts and theories would be more coherent to students if they were taught in the context of cell biology, instead of being spread across multiple subjects in biology. "There are some communication issues within my department. We are not all the best of buddies, so that is hard sometimes to get past that and be professional and learn from each other. There have been some falling-outs over the past few years because I pushed the issue of this year-long biology, and I think that threatens a few people. Some people don't want it, so I've noticed a change in personalities. That makes a little bit of a difference as well. It's harder for me to walk up to somebody sometimes because of this rift" (Interview with Holly, 5/1/2001). Even though the year-long biology course was a source of tension in the department, it is to be noted that the tension arose around an issue of student learning.

Within any group of individuals, tensions and conflicts will undoubtedly rise from time to time. A high school department is no exception to this rule, even when it has a strong focus such as teaching for understanding. Knight (2000) noted four factors that run across many situations where tensions arise: (a) a history of interpersonal conflict with other teachers, (b) feeling overwhelmed by tasks teachers must complete, (c) resentment

about top-down decision making in the district, and (d) anxiety about changes occurring in schools. These factors must be minimized if teacher learning is to take place. According to Robinson (1979), creating a learning atmosphere of mutual support is a key principle of adult learning. Tensions and mutual support run counter to each other, and the latter must prevail if the enhancement of teaching practices is to occur.

Holly indicated that it was difficult to ask questions of some of the science teachers, but for Betty, communicating with her colleagues was a big part of how she improved her teaching practice. She relied on mutual support, the sharing of ideas, and collaborating with those teachers with whom she worked the closest (Lauren, Laura, and Louis). With these teachers, Betty had cultivated norms of constructive criticism and trust that were less fully developed with other science teachers, like Holly and Marianne. While interpersonal trust was an important factor in the actions of this group, internal trust also played a role. Betty and other adult learners tend to be goal oriented. In other words, adults engage in a learning activity in order to achieve a particular goal. The adult must trust that there is a reasonable chance that this goal will be achieved, or psychological or behavioral barriers may be created that impede the development of learning outcomes (Merriam & Caffarella, 1991).

For example, Betty was working with Louis, Lauren, and Laura on developing a tenth grade assessment. The administration decided that knowing how well students were understanding science concepts was a piece of data that would be useful to have and was not currently being gathered. Since responses to multiple-choice type questions would not provide the evidence of student understanding that was desired, short answer questions, essay questions, and problems needed to be created. During interviews, all of the

members of this group of science teachers agreed that the discussions around the development of the questions were sometimes stressful. Doing the best job possible was seen as the common goal, and sometimes that meant asking hard questions of one another or closely testing someone's ideas. Constructive criticism assisted in the development of effective test questions, but it could also have strained relationships within the group had it not been for the level of trust that existed. Each teacher expressed that he or she knew when a tough question was posed to them or they were asked to defend their position, the task was driving the query and not some personal motive. They had worked together long enough to trust each other not to personally offend or otherwise hurt a member of their group. The workings of this group exhibited in this and other examples are closely related to Lord's (1994) ideas of critical colleagueship:

- Creating and sustaining productive disequilibrium[5] through self-reflection, collegial dialogue, and on-going critique
- Embracing fundamental intellectual virtues
- Increasing the capacity for empathetic understanding (placing oneself in a colleague's shoes)
- Developing and honing the skills and attributes associated with negotiation, improved communication, and the resolution of competing interests
- Increasing teachers' comfort with high levels of ambiguity and uncertainty, which are regular features of teaching for understanding
- Achieving collective generativity as a goal of successful inquiry and practice.

[5] Note that disequilibrium is seen here as an impetus for continued learning and, therefore, a positive feature. This contrasts with tensions which are seen as detrimental to teacher learning.

According to Betty, at the heart of developing the tenth grade assessment was a researchable question: How can a science assessment be developed that allows students to display their understandings of important concepts and ideas? Addressing this researchable question represented a learning goal for Betty. She utilized many resources including old test questions she had developed, ideas from on-line resources, and other books and materials available in the science department. In addition, she also used human resources that included the ideas and experiences from her teaching colleagues. Louis, Lauren, and Laura all had advanced degrees in science, had many years of teaching experience, and had participated in multiple and varied forms of professional development. All of this could be brought to bear on the task of developing the assessment. The assessment was implemented in a number of classrooms, and the experiences of administering it along with the responses of the students were shared and closely examined. These experiences provided another resource that Betty and the other science teachers utilized in their continuing search for better ways of teaching.

Betty was very comfortable interacting with Lauren, Laura, and Louis since they worked closely and had "grown up together," so she could more easily ask critical questions. It was harder working with their substitutes (Lauren and Laura were on maternity leave, but they worked on the tenth grade assessment as a side project) because the subs didn't ask many questions. It was also harder working with the regular teachers that Betty didn't work closely with, like Holly and Marianne. This is not to say that questions were not posed; they were. It was just more awkward posing them at times. "It's awkward in asking them questions. With a student, I would ask them questions to find out what they know. But with a professional, that is not always perceived as being

helpful. It's more prying. 'What's she trying to find out, what I know and what I don't know?' They're a little more defensive, so it's a little more awkward sharing with a professional than it is with a student. A student expects you to do that. That's your relationship with them. They know you are trying to find out what they know so you can help them" (Interview with Betty, 5/30/2001). Holly and Marianne might be the type of teacher that would see Betty prying, along with the subs (although the sub might be willing to accept any help in any form, particularly if she or he had a poor science subject matter background). This may have led to less-than-optimal interactions for enhancing teaching practices.

The Teacher Education Program

The university's teacher education program also had an influence on the context of this science department. There were three interns placed in this department during the 2000-01 school year. The technical language used in the teacher education program was familiar to many of the mentor teachers. Five of the mentors were graduates of the university's program, with two of these five completing their internship at Heisenberg High School. "I think the entire department would agree that as a department we believe in the conceptual change model and teaching for understanding and the learning cycle and all the kind of stuff they teach in the teacher education classes. I think we put it all into practice here. So that kind of foundation I think is the same" (Interview with Holly, 5/1/2001). Indeed, "modeling", "coaching", and "fading" (three phases of the learning cycle) were terms that were repeatedly heard in the interviews with the science teachers and in the conversations between Betty and her intern.

Betty had been a mentor teacher to approximately one dozen interns over the years. She was familiar with the structure and expectations of the internship. She had worked with interns who excelled at teaching and a couple who struggled. She had command of the "technical language" used in the teacher education program. This was due not only to her experiences of being a mentor teacher, but also to her experience of teaching in the teacher education program. She taught the Friday course that focused on science teaching (TE 802, TE 804) with two university professors in the mid-1990's.

The interns believed their presence led to the improvement of their mentors' teaching practices. "I think they look at their interns as coming in with fresh ideas. Maybe they're not always the greatest. If they don't pick up a whole lesson, they can pick up points of it. Stuff that maybe they think is better than the way they've been teaching it. I do think that just because of their attitudes about teaching" (Interview with Cathy, 4/20/2001). "I think they definitely view it as a way of improving their teaching. I know Holly has many times said, 'This is one of the reasons I have interns. I learn just as much from them as they learn from me'" (Interview with Mandy, 4/20/2001). Although one might think that the assignments given in the teacher education courses might be central to discussions between the mentor and the intern that would allow for both to deeply consider important topics in learning to teach, these instances occurred infrequently.

By observing Betty's mentoring practices, it was evident she believed that one of the purposes of the internship was to help interns begin to look critically at their teaching practice. During a conversation, Betty expressed her thoughts concerning the ability for a teacher to look at their teaching, identify the weak points, develop a researchable question, and address this question with teacher-initiated ideas that incorporate materials

from multiple sources. She initiated discussions and activities with Cathy that explored this approach. In a couple of instances, Betty stated she was hoping to instill a habit of mind in Cathy that allowed her to reflect upon her teaching and constantly strive for ways of improving it. Eventually, Betty would ask Cathy to do this work for a weakness Betty had identified (discussed in the first occasion for learning). Thus, developing an important habit of mind in her intern would eventually assist Betty in her own development of her teaching. In this manner, Betty was utilizing Cathy as a human resource, much like she used Louis, Lauren, and Laura as human resources.

During multiple interviews, Betty openly expressed a desire to keep learning. However, the benefit she was getting from the professional development activities sponsored by the high school or district had declined. "The last five years our professional development has kind of gone down, and I'm not getting the stimulation I used to get outside when I worked with the university professors. They were out here, and they were doing all kinds of projects. But working with an intern takes the place of a lot of that. I still, with her [Cathy] problems and her questions, are still challenging enough that they help me to learn. I'm still learning quite a bit, I really think. So, I enjoy doing it. She asks good questions. They all do, all the interns. They're not afraid to say "Why did you do it that way" or "Did you mean to do that?" [laughs]. No, I didn't. [laughs] I wasn't expecting that outcome" (Interview with Betty, 2/5/2001).

Even though Betty had over 25 years of teaching experience, she still viewed herself as a learner. She was motivated enough to continue to find avenues for her learning. Working with an intern provided her with the opportunity to not only be

challenged by the questions of a novice, but also to create situations where the two of them could investigate an issue together.

Key Aspects of the Context That Will Be Reflected in the Occasions for Learning

The context described thus far includes some important aspects that will be seen again in the discussion of Betty's personal factors and in the discussion of the two occasions for learning. These aspects include:

Mutual trust and constructive criticism. Patterns of practice related to communicating with others in the department were well established, which led to mutual trust among the members of the science department (if not within the entire department at least within sub-groups). This included a shared technical language that helped them with the goal of students learning with understanding and allowed for constructive feedback and sophisticated dialogue to occur, such as during the development of the tenth grade assessment.

Locating and utilizing relevant human and material resources. The science department was well stocked with material resources. There was an ample amount of supplies and equipment for a variety of laboratory experiments, demonstrations, student-initiated projects, examples to be used during lessons, etc. The teaching staff had a variety of experiences and backgrounds that allowed for multiple perspectives to be brought to the table in a discussion.

Formulating researchable questions. Much of the interaction among science department faculty members dealt with student learning, and an atmosphere existed where the asking of questions related to teaching was appropriate and encouraged. For example, along with the researchable question associated with the tenth grade

assessment, the activity brought back from the NSTA conference helped to answer another researchable question that dealt with how to find opportunities in the science curriculum to assist with the learning needs of low-achieving students.

Scaffolded collaborative work on problems. The science teachers shared ideas and the ample available material resources to collaborate on projects where increasing the effectiveness of their teaching with a corresponding effect on student learning was the goal. Other teachers were seen as valuable human resources for their ideas and experiences. Cathy was seen as a human resource, just as Betty's teaching colleagues (in particular Louis, Lauren, and Laura) were seen in this manner. Betty viewed Cathy's knowledge and experience as valuable for her own learning. Betty put time and effort into setting up teaching problems (for her students, her colleagues, and her intern) that would become the topic of interactions and worked hard to provide supports for learning, for both her and others, during these interactions.

Collecting and using empirical data to develop new ideas and strategies. Multiple teachers used the same activity in their classrooms and compared the effectiveness of this activity on student understanding with other teachers by using examples of student work and events from the lesson in their discussions. Thus, the number of times an idea was tried was increased as was the quality of the feedback since multiple teachers were involved with lots of students, and data from each of these classes were available for analysis. This analysis by groups of teachers many times led to new ideas and strategies for teaching a particular concept. Two examples where this took place were the dinosaur activity and the tenth grade assessment.

Multiple examples and a continuing search for better solutions. One social resource was the school-wide expectation that students were to learn with understanding. Since many of these science teachers view understanding as being able to link new knowledge to prior knowledge in productive ways, many techniques and examples were needed if students were going to succeed. Thus, the science teachers were to continually look for ways of improving their teaching practice.

It stands to reason that Betty found working with her intern to be beneficial to the enhancement of her teaching. From working in this department, she already possessed the habit of mind to work with others to improve her teaching practice. Betty knew of ways to interact with others so that productive and meaningful outcomes were likely to result. She could effectively communicate with her intern since she already possessed a technical vocabulary that was consistent with the terminology used in the teacher education program. Thus, Betty was well positioned to learn from the experience of being a mentor teacher, a position that in no small part was the result of being a member of this department.

A Focus on Learners and Purposes: The Effect of Personal Factors

Personal factors include many internal attributes. Beliefs, perceptions, behaviors, and attitudes affect teachers' actions and decisions in the classroom and teacher learning from practice (Desouza & Czerniak, 2003), along with the role of experience. Among the necessary conditions for learning from experience, teachers mention time, maturity, and interactions with others (Ben-Peretz, 2002). In addition, teachers' frames (Barnes, 1992) and personal practice theories also play a role. A teacher's frame is an outline scheme which, running ahead of experience, defines and guides it. A frame helps teachers

determine the features of a situation to which they will attend, the order they will attempt to impose on the situation, and the directions in which they will try to change it. Personal practice theories may be defined as being the systematic set of beliefs (theories) which guide the teacher and are based on prior life experiences (personal) derived from non-teaching activities and also from experiences that occur as a result of designing and implementing the curriculum through instruction (practice) (Cornett, 1990; Cornett, Yeotis, & Terwilliger, 1990). Related to teachers' frames and personal practice theories are philosophies of teaching and student learning and the nature of actual teaching practices.

Betty's Philosophies of Teaching and Student Learning

The ultimate goal Betty had for her teaching was to make her students independent, which would indicate their understanding of important ideas and concepts in science. She showed them how something was done (modeling), assisted her students as they tried it on their own (coaching), and then had the expectation that the students would be able to do it independently (fading). The scaffolding activities she planned for her classes during the coaching phase helped students make connections.

The coaching phase of the learning cycle (establishing the problem, modeling, coaching, fading, and maintenance) was of particular importance to Betty. In fact, she believed it was critical for students to practice problems in a small group of their peers before attempting the problems on their own. She believed this so much that she frequently told students not to do problems as homework, until she believed they were ready to try them on their own in the fading stage. Students typically watched Betty do a genetics problem at the board and then they did one together as a class. "But in my

experience, if they go home and try and do it on their own, they forget the steps. They fall back on what they think is the way to do it, and if they practice that, it's much harder for me to prevent them from doing it. If they practice it too much the wrong way, it's too hard to get them to do it the right way. But if they're in their groups, there are enough of them to say, 'Hey wait a minute. What's the first step?' If they do that first step, in my experience, they don't have trouble with it, and if that can become part of a reflex for them, now, it will save them time down the road. It's almost like they make the whole process more difficult, but they need to help each other at this point. It's still very fragile in their mind. They haven't learned it yet, so they need to pool their ideas and learn together. Then later, I'll fade out, and they'll have to do it on their own, eventually for the test. They're not ready yet to be able to solo. They need to help each other out" (Interview with Betty, 2/5/2001).

Thus, Betty believed that knowledge is co-constructed. Learning is a collaborative process that happens best when individuals work together on a carefully formulated task. These tasks involve the application of new knowledge to a variety of situations and carefully defined standards for adequate solutions. "To hang on to what we talked about on Friday, we needed to visit it again today, and they need to use it to solve problems and to practice" (Interview with Betty, 2/5/2001). Having students apply new knowledge to specific circumstances assisted in the development of connections. She frequently asked her students "What would happen if...?" type questions where Betty used a particular set of circumstances with which most students were familiar in the question. Betty had a strongly held belief that learning is all about making connections, connections of new knowledge to prior knowledge. "I have this visual of what a brain is... you put a piece of

knowledge in there, but it will float away if you don't hook it to something real fast. The more connections you have, the better hold you're going to have on it, and you'll be able to use it much better and connect it in many ways" (Interview with Betty, 2/5/2001).

However, not all connections a student might make are equally productive. The connections must be those that are reoccurring and useful to the student. Thus, Betty believed she needed to know her students very well in order for their learning to have any meaning for them in the present. She went to great lengths to learn about her students and how to make the curriculum relevant to their lives.

Betty summed up her work as "Teaching is helping someone to learn. You have to find out what they know and start there. Identify what you want them to learn. Find out what they know. What do they need to know to get to the goal (the steps)? If they don't have the prior knowledge, how are you going to help them to get it? If they do have prior knowledge, how do you help them link the new concept to their prior knowledge? How do you know they know it (to see them apply the new knowledge), some evidence that they know it?" (Interview with Betty, 5/30/2001).

This same philosophy was used by Betty when helping her intern learn to teach. In many ways, she was acting in the role of "mentor as educational companion" (Feiman-Nemser & Parker, 1992). Learning to uncover student thinking and developing sound reasons for teacher actions are important in teaching for understanding. They are also complex, much like many of the concepts and ideas Betty wanted her students to learn. Thus, she used a version of the learning cycle with Cathy to help her develop these practices. Betty inquired with Cathy into the particulars of their teaching situation, asking questions such as, "What sense did students make of that assignment? Why did you

decide on this activity? How could we find out whether it worked?" Questions such as these were used in many of the planning periods when Betty and Cathy discussed past and future lessons.

The Nature of Betty's Teaching Practices

The teaching cycle is used to explore Betty's teaching practice.

Planning. Betty needed to develop in students an understanding of the big ideas that were consistent with state and national frameworks and their application to multiple examples. One way she accomplished this was to plan interesting cases where students had the opportunity to work with real data. In this planning, she took into account students' personal interests, social relationships, and students' prior scientific ideas and misconceptions.

Betty used many resources in her planning. She utilized the material resources available to her in the science department, such as books, videos, laserdiscs, laboratory procedures, materials for demonstrations, and many manipulatives. She also used resources from the Internet. In addition, the experiences and expertise from her teaching colleagues was invaluable. Frequent questions were posed to fellow teachers when Betty was planning a specific activity, a daily lesson, or for the next unit.

One goal Betty had for the activities she planned was to deeply engage the students with the subject matter. "I have to show them that science is not only for geeks. It's boring if it isn't relevant. It's got to connect to their immediate lives. They have to be involved. They can't be sitting there having it come at them. They have to be processing and synthesizing in their heads. If they can do that, then it is for them, not just for the bright kids. I show them the mistakes and flaws of noted scientists because they think

scientists don't make mistakes. They think every experiment works. If you want them to truly believe that science is something they can do, they have to have success at it" (Interview with Betty. 5/15/2001). Thus, Betty planned activities that took into account her students' backgrounds and interests. Since these are varied, flexibility within each activity, and the strategies used to investigate the researchable question upon which it was based, was needed.

Teaching. Betty wanted her students to take an active role in their learning by having them teach lessons, work in small groups, lead class discussions on stories from readings, etc. The whole genetics course was set up so that as the students were practicing one concept, they were introduced to the next. These interlocking learning cycles were seamless, and the students didn't see the transitions. She built her learning cycles around questions that her students could do their own research on, such as: Are yeast alive? What is the cause of cholera? What are the chances of offspring inheriting different genetic traits or diseases from their parents? Students collected empirical data on these questions, analyzed these data, and collectively came to an interpretation. In a heterogeneously grouped class, problems that are challenging to the upper level kids are needed, but problems that a teacher can "fade" on with the other students that are still learning are also essential. She constructed small groups that worked together over extended periods of time on the basis of how well each student would "push" other students' thinking in the group. Betty liked to teach using case studies with multiple learning cycles embedded in them that address common misconceptions students had. Sometimes she developed illustrative scenarios within the case studies to emphasize certain elements (sometimes the students developed the scenarios). Within these

scenarios there were many opportunities for Betty and students to ask "What would happen if...?" type questions of each other.

Assessment. Giving a formal assessment was the way Betty monitored her teaching performance. "I don't think assessments are just for kids. I think they're for the teachers. They give me feedback on how I am doing, definitely. When I give an assessment, I don't give multiple choice or true and false tests. I give the kids problems, and they have to solve them and write. That's where I get my assessment of myself, not just them, but how did I do. If I get the same mistake or the same misconception from kid to kid to kid to kid, then I know it's my fault. So when I do an assessment there might be six problems, and if I grade number two all the way across the board, not a kid's paper but all number two's, I get a feeling, a real strong feeling for what I did wrong. Then I write little notes. The next time I'd like to try, or I talk to my peers, 'What should we do differently if that happens?', 'How can we hit it again coming up in the next unit?'" (Interview with Betty, 2/5/2001). Thus, it would be most beneficial if the questions or problems on these assessments were constructed in ways that allowed students to display their reasoning processes in their responses. Developing this type of question is a complex task, one that Betty spent much time and effort on since the feedback she gained from the analysis of student responses was critical information for her approach to improving her teaching practice.

Reflection. In order to determine if students were making sense of concepts and ideas, Betty used not only formal assessments, but informal ones as well. She was constantly monitoring student discussions in small groups and reflected on the questions students asked during whole group discussions. This information was used to alter her

teaching for different groups of students. For example, the way in which Betty taught Genetics I in the fall to juniors and seniors was different than in the spring semester. In the fall, students had completed physiology, zoology or botany already, so their prior knowledge was different than the spring semester students who only had Biology I. The informal assessments helped Betty make sense of her students' prior knowledge so that she could reflect on ways to foster connections to be made with the new knowledge. Her reflection also allowed for the formulation of new researchable questions that could assist with the enhancement of her teaching practice. These questions were related to her ideas as a teacher about her practice as well as questions she developed for her students to explore during science class.

Key Aspects of the Personal Factors That Will Be Reflected in the Occasions for Learning

The aspects that were discussed at the end of the section on context also appeared in this discussion of Betty's personal factors.

Mutual trust and constructive criticism. Betty had her students work in small groups much of the time. These groups were not randomly assigned, but instead Betty purposefully had students work together who would augment one another in developing understandings of key ideas and concepts. Therefore, varying perspectives were a part of each group, which could lead to constructive dialogue. She designed her teaching practice around the students' active role that she expected them to take in their learning. Betty utilized activities that provided many opportunities for students to ask and respond to "What would happen if..." type questions. Since many of these questions did not have

clear right and wrong answers, students learned to evaluate and respect alternative viewpoints.

Locating and utilizing relevant human and material resources. Betty relied on a multitude of resources in her teaching practice. She used the material resources available in the science department, ideas from interactions with her teaching colleagues, activities found on the Internet, etc. She found effective ways of incorporating these resources into her lessons so that student understanding was an outcome. Betty mixed videos, labs, stories, print resources, etc. in a typical learning cycle. She also used these resources to develop assessment tasks that would help her understand student reasoning.

Formulating researchable questions. Betty built her learning cycles around questions that her students could do their own research on. Assessments were used to not only determine how well students were understanding, but also provided valuable feedback to the teacher on her performance. For this to occur, assessments must be designed that make student thinking and reasoning visible. Betty saw student questions as a window into how a student was attempting to make a connection between what he or she already knew and the new knowledge being presented. Looking for patterns in student work and the questions they asked helped to identify misconceptions and future researchable questions about teaching practices.

Scaffolded collaborative work on problems. Working together on carefully planned tasks led to the co-construction of knowledge by the students. Members of a group acted in ways that supported each others' learning by asking appropriate questions and helping each other to not only complete a task, but to understand the associated ideas and concepts. Application of new knowledge, which is tentatively held at first, to a

variety of situations in small groups was a way Betty helped her students to make connections.

Collecting and using empirical data to develop new ideas and strategies. Students were engaged in activities such as case studies where data were generated in laboratory, library, virtual, etc. settings that were analyzed and evaluated to test assumptions and hypotheses. She had her students using empirical data to address theoretical/conceptual questions. Based on their findings, new hypotheses were formulated and tested with empirical data, which formed the basis of further learning cycles.

Multiple examples and a continuing search for better solutions. Making connections between currently held knowledge and new knowledge was seen as being important. Robust connections were not possible if they were not used, so many applications were needed. These connections were complex and required sophisticated means to support their creation and development. Thus, Betty saw the need for many relevant experiences for the students where new knowledge could be employed. She was always looking for vivid, meaningful, and effective ways to enhance student understanding of powerful ideas.

A Focus on the Local Learning Community and Activities: Two Occasions for Learning

The Identification of "What" Is to Be Learned

Betty's view of teaching science for understanding was rather sophisticated. It seemed that the model Betty used depicted teaching for understanding (TFU) as occurring at the intersection of three bodies of knowledge and practice: (a) knowledge of all students and effectively interacting with them, (b) subject matter knowledge and its

application in teaching, and (c) knowledge of a variety of teaching strategies and their application. Figure 2 is a representation of this intersection.

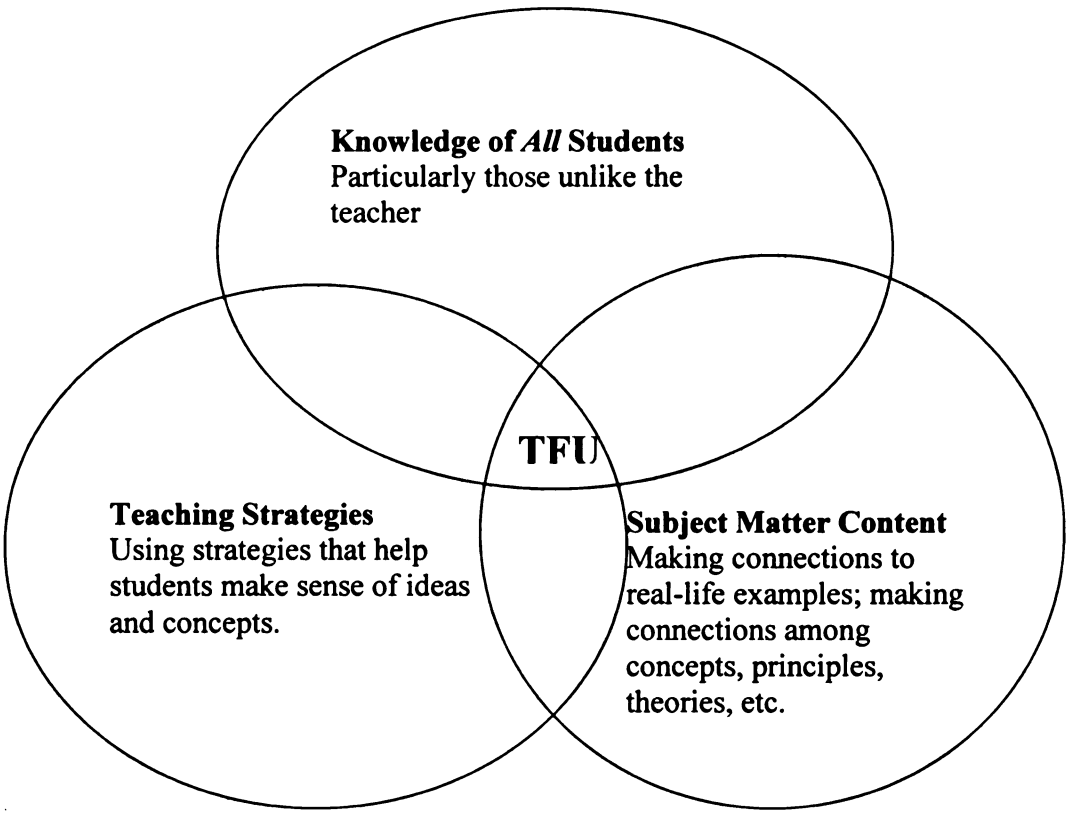


Figure 2. Teaching for Understanding (TFU) depicted as occurring at the intersection of three bodies of knowledge and practice.

This pattern of practice put demands on what Betty needed to know and be able to do. In order to teach using this model, she needed to continually learn about her students, the subject matter, and effective teaching strategies. She used learning cycles that assisted with the connections to be made between the subject matter she was teaching and the students' prior understandings. Modeling, coaching, and fading are aspects of the learning cycle that were evident in almost every one of her lessons.

Betty's practice is consistent with the guiding framework of teaching for understanding as described in Wiske (1998). Four key questions are central to Wiske's approach:

- What topics are worth understanding? (related to the subject matter content)
- What about these topics needs to be understood? (also related to the subject matter content)
- How can we foster understanding? (related to teaching strategies)
- How can we tell what students understand? (related to knowledge of all students)

Betty's practice is also congruent with Bybee's (1997) ideas associated with designing science curricula (and appropriate teaching strategies). He states that this process should begin not by outlining the content of the discipline (although this is important and related to the subject matter content), but by asking what it is students ought to know, value, and do as a citizen (which can only be achieved by knowing students).

Among other things, Betty's teaching practice consisted of continuous loops through the teaching cycle. In other words, the responses on an assessment were reflected upon. The results of the reflection process were used in planning the next set of activities. These plans were then enacted in the teaching of lessons and units. To ascertain whether the teaching had an effect on student learning, an assessment was given, either formally or informally. These responses were reflected upon, and the cycle continued.

During the reflection process, it was possible for Betty to determine where weaknesses in her teaching practice existed. These weaknesses were used as the basis for formulating researchable questions. The processes used to address these questions could include occasions for learning about the teaching cycle.

In responding to an interview question about her practices related to the teaching cycle, Betty stated that she had a big picture of the direction where she wanted her students to head, but there were weak spots in this plan. Working with an intern could help her to address these weak spots. In teaching, she felt she needed to address the learning needs of individual students better. Thus, Cathy, who was familiar with Betty's students, could assist with the identification of these needs and help figure out ways of teaching to those needs. There are two fundamental points to be made here: (a) Betty's teaching practices and standards generated the need for a lot of knowledge, and (b) Betty used reflection to generate researchable questions that drove her learning.

Let us now turn our attention to two examples of the specific activities in which Betty participated to enhance her teaching practices during the internship. The first concerns the development of curriculum, namely a lab that addressed a common misconception among students associated with mitosis (the splitting of non-sex cells in the body). In the second, Betty created an occasion to assist in the development of questions on a student assessment that would be administered to her genetics students. Both of these occasions for learning are investigated using the strategy for learning Betty employed, which is based on the important aspects of context and personal factors discussed previously:

- Creating an atmosphere of mutual trust and constructive criticism
- Reliance on carefully formulated researchable questions
- Locating and utilizing relevant human and material resources
- Collecting and using empirical data to develop new ideas and strategies
- Scaffolded collaborative work on problems

- Multiple examples and a continuing search for better solutions

Occasion One: Developing Curriculum During the Planning Period- The Mitosis Lab

Creating an atmosphere of mutual trust and constructive criticism. Both Betty and Cathy had high expectations for their students. Betty was very relaxed with Cathy and non-judgmental. She set a very comfortable setting with her humor and her relaxed approach to planning. She realized that Cathy was learning to teach, and she did not make a big deal out of little things. She pushed Cathy, but did not put undue pressure on her. The students were central to their discussion of what to do and how to sequence it. Betty talked about the current set of students and how they might relate to the activities, and she also relied on her experience with prior sets of students to determine when her current students might be ready to understand a concept or topic. This was a big part of this discussion. Discussing these things with Cathy was helpful to Betty in determining what and how to teach to this particular group of students.

Creating this atmosphere undoubtedly was informed by years of experience as a mentor. Betty was able to recall approaches she had used in the past with interns who were similar to Cathy. She had experience with what had worked well and what had not, and she was able to adapt the things that worked well in the past to situations that arose with Cathy in the present.

As was noted earlier, one of the social resources in this science department was the way in which teachers communicate. Betty had habits of mind and practices that allowed her to interact with a variety of individuals, including Cathy. From her years of mentoring experience, Betty realized that interacting with an intern was not the same as interacting with students or colleagues (be it those she worked closely with or others, like

Marianne and Holly). She relied on her habits and practices to foster a new means of communication with Cathy, which aided in both Cathy's learning to teach and Betty's enhancement of her teaching practices.

Interviewer: So where would you put the intern? How do you view her?

Betty: It depends. I wouldn't treat her like I would my sophomores, in finding out what they know. When I work with an intern like Cathy, one of the first things I explain to them is that I do not know what you know. I'm going to have to ask you questions, and you're going to have to ask me questions. We're going to have to be okay with that. We're going to have to do that because we are going to be joined at the hip. We're going to have a lot of learning to do about each other and helping each other. I just kind of lay it all out. There are going to be times when I ask you a question and you're going to see me modeling, coaching, and fading throughout the year. We just show our guts. You are trying to totally open up your brain and show them everything that's in there. They're doing the same thing to you. All the questions and all the ideas they have. You have to bare your soul. I think you know each other a little bit better. If I explain something to Cathy, I feel more comfortable that she's getting it than if I explain it to, say, Marianne. The same activity. Cathy can almost finish my sentences.

Interviewer: Are the nature of the questions different as well?

Betty: Yes. Cathy's would be like the student, more of a clarifying question. 'So do you mean this and that is why this would happen?' If I have done it successfully, the question will be more of a verification question. 'Do I have it right now?' If I haven't done it very clearly, they are going to ask more questions

that are off-the-wall. They're not making connections. So Marianne's questions would be more along the lines of questions that show me she is not understanding my point. With Cathy I can usually explain it so that she doesn't have questions like that. I know her and how she thinks and how she learns and what she knows. When I explain it to her, her questions are usually little detail questions. It's harder to work with people you aren't real close with. (Interview with Betty, 5/30/2001)

Thus, the type of communication needed to work with an intern is not exactly the same as that needed to work with a high school student or with teacher colleagues. In some ways it is a hybrid of the two. Betty still relied on questions as a key part of any interaction with her intern, just as she did with her high school students. She made it clear early on that she will use this strategy since she and her intern will be working closely together over an extended period of time. However, her questions exhibited an understanding that her intern had some knowledge about the subject matter and teaching science. Betty did not view her intern as a "blank slate", just as her teacher colleagues were not viewed in this manner by Betty.

In other ways, the communication between Betty and her intern was something quite different than either interacting with high school students or teacher colleagues. Her intern had knowledge about the students in the classes and the manner in which they were being taught and learning the ideas and concepts. She critically reflected on any of the questions or observations Betty put forth. Their dialogue was built on each others' experiences and insights and in this way was quite constructive. Therefore, the types of questions asked by Betty during an interaction with Cathy could be very detailed and

specific to classroom situations and/or students. They had the potential to develop their own "technical language" where they could finish each other's sentences. Even though baring one's soul to another means baring both the good and the bad, Betty was willing to accept any discomfort this might entail in the pursuit of improving both Cathy's and her teaching practice.

This situation with her intern was similar to the situations Betty encountered with members of the science department at her school. She used different means of communication whether she was asking questions of her closest colleagues (where norms of trust and constructive criticism were well established) or with others in the department who might see her questions as an intrusion. Thus, it was important for Betty to establish norms of trust with Cathy early in the internship (e.g., the willingness to bare her soul) so that when occasions for learning emerged, the hard questions could be asked of each other without the feeling that personal motives were the driving purpose of the question instead of the improvement of teaching practices.

In many ways, Betty was following the suggestions for opening and developing lines of communication between mentor and mentee that are found in the literature. For example, from their work with cooperating teachers in Great Britain, Field and Field (1994) suggest the following as being important to effective communication during an internship:

- Be a good listener
- Try not to "tell"
- Ask "open" questions
- Allow time for thinking and reflecting before answering

- Respect others' opinions
- Be assertive, but not aggressive
- Recognize the others' rights
- Be honest – don't hedge
- Show care and concern
- Have a set time that cannot be interrupted
- Recognize that mentoring and learning to teach is a two way process
- Don't overload the novice teacher with information

There was an element of respect that Betty showed toward Cathy. This was due, at least in part, to the different set of experiences and perspectives Cathy brought with her to the internship. These differences could be used in constructive dialogue between Betty and Cathy. Betty was excited to work with Cathy since Cathy has

> more experiences I haven't had. She's done more research than I have done in the field. I've been in labs doing work, but I was never part of the actual decision making in research. I just kind of did what they said to do. She was actually involved in research in the Antarctic and stuff like that, so she's rich in knowledge about that sort of thing. So I was really looking forward to working with her and seeing how we could tie that into what we're doing with the kids here...She's also taught at the university level, so I like talking to her about how it's different here than there and what kind of problems she faces here that she didn't' face there and vice versa.
>
> Interviewer: So how does that help your teaching?

Betty: It helps me because it talks about, it makes us talk about the learning process, like the needs of these kids are different than the needs of the university kids. See how she perceived it and how we do things differently and why we do them here and not there. Like what are their needs here? How are they different? Why do we do things differently? So it sets up a nice contrast. (Interview with Betty, 2/5/2001)

Betty is noting that she and Cathy come to the internship with different experiences and expertise. These varying perspectives are important if teaching practices are to be enhanced. According to Little (1990), the intellectual capabilities and dispositions that colleagues bring to their work and the quality of the products that follow from their joint ventures are crucial to teacher learning. However, a conducive environment must be established where the expression of different ideas and viewpoints is respected, if not embraced. The culture of teachers sometimes prevents this from happening due to the prevailing norm in many schools where one teacher does not question another teacher's practices and beliefs (Buchmann, 1990).

Reliance on carefully formulated researchable questions. Every year Betty presented her intern with a challenge. This year her challenge to Cathy was to help students understand that cells do more than just divide. I asked Betty how she identified this misconception. "When I would teach later in the unit, the students would always comment on it. Whenever they would draw a cell, it was always in the dividing phase instead of its functioning phase. That always bothered me. From our discussions, I always felt that they didn't get a good grasp for what the cells were really like. If I could shrink them down and put them inside the cell, what would they see inside a cell, and they really

don't know. In fact, students have often said, 'I thought all they did was divide.' That has actually come out of their mouths before, or I read it in their journals, or answering a test question. It has always bothered me" (Interview with Betty, 2/22/2001). Thus, Betty planned to use Cathy's ideas for an activity (a human resource) to address a misconception that was identified by using multiple sources (student questions, journal entries, responses to test questions). The identification of this misconception was a product of the reflective process in which Betty constantly engages.

"Kids think that all cells do is grow and divide. They think that mitosis is what cells do. They don't realize that cells have a big function to keep us going. Very little of their time should be in mitosis because if those chromosomes are all coiled up and going through division, then the genes aren't functioning. We need to get the cells through so the genes can do what they are supposed to do. That's a problem" (Interview with Betty, 2/20/2001). This led to Betty's researchable question which was: What activity can be designed and effectively implemented so that students understand the role and function of mitosis in the life cycle of a cell? It can be argued that if Betty's teaching practice were not as complex as it was, particularly the assessment and reflection pieces, then the student misconception might never have been identified. It is also important to note that Betty identified this issue as one worthy of study. Identifying one's own goals or topics for learning is an important part of effective learning for adults (Merriam & Caffarella, 1991).

Mitosis re-occurred at different points in the curriculum, so it was important to address. This was a legitimate task. It was not designed to see if Cathy could find a teaching strategy that Betty already knew existed. This was something that Betty would

be working on if she were teaching by herself. However, she thought it was better to have two individuals working on a teaching problem since "bouncing ideas back and forth will always yield better results than if you do it by yourself" (Interview with Betty, 2/12/2001). The purpose of this occasion for learning was to work with a common student misconception that cells spend most of their time in mitosis. Betty challenged Cathy to look at this unit and find ways to make it better.

Locating and utilizing relevant human and material resources. Betty provided Cathy with some scaffolding for her work. She showed Cathy the resources she had available, explained to her what she had tried in past lessons and units, shared the strategies other interns used and explained what went wrong, and described where she saw the weaknesses in the lesson(s). "My challenge to Cathy was to come up with a way that we could actually calculate the percent of the life cycle that was mitosis, in a part of a living thing that we would expect to divide. The kids could be a part of collecting that data. I heard of someone doing this. I told her what I had heard through the grapevine about another teacher in another state. Could she figure out a way to do that?" (Interview with Betty, 2/12/2001)

Here multiple resources are playing a crucial role. The human resources of Betty and Cathy are important along with the material and social resources that are gathered and developed. These resources directly affect "the behavior of an individual within a specific 'local' setting" (Salomon, 1993, p. 168). If materials, participants, and activities differ from one area to another, affordances of each location may be different as well. These affordances could lead to learning outcomes that might enhance Betty's teaching practice. Thus, having a great number of resources of high quality was critical to Betty.

Scaffolded collaborative work on problems. Betty used her theory of learning to create this situation from which she might profit. She was purposeful in setting up discussions like this one during the internship. Since Betty believed knowledge is co-constructed, she needed opportunities to interact with her intern. Thus, each planning period was set aside for conversations with Cathy. However, these were not sessions where they only discussed topics that were pressing at the moment. Betty scaffolded many of the activities that took place (just as she did with her students) by presenting Cathy with a challenge and resources that could be used in their discussions. Combining this with Cathy's perspectives on teaching (a human resource) created a rich space where an activity was designed that could be applied in the classroom.

I was present at the planning session the day Cathy presented her ideas to Betty. Cathy's idea was to have the students take microscope slides and count how many cells were in the stage of mitosis while they were doing the regular assigned activity for this topic. After Cathy described her plans to Betty, Betty expressed interest in the idea, but felt that it needed to be tweaked slightly.

> Betty: What if you asked them how to do this? I mean if you showed them a life cycle, and you said "How long do you think this is?" And they can't tell. Well, how could we find out? I wonder if they could.
>
> Cathy: Then it would be all of their ideas.
>
> Betty: Yeah, good idea. Let's do that. I wonder if they could do that. I think fourth hour might be able to. I'm curious if anyone will say, "What does the cell do the rest of the time?"
>
> Cathy: Grow. Function. (Notes from the planning meeting, 2/9/2001)

Learning as co-constructing knowledge (Resnick, Levine, & Teasley, 1991; Rogoff & Lave, 1999; Salomon, 1993) was a cornerstone of Betty's theory of learning. After Cathy presented her ideas for an activity, Betty asked her three key questions: What if you asked them how to do this? How could we find out? What does the cell do the rest of the time? These questions were of central importance to not only the students' making sense of the life functions of a cell, but also to the purpose of the activity Cathy had proposed. Through this dialogue Betty made a connection between the student misconception she had identified and the role this activity could play in addressing this misconception. It can be argued that the construction of this connection was supported by the interaction between the expression of Cathy's ideas and Betty's prior knowledge of student difficulties in learning this concept. Cathy's plans and their discussion acted as tools in this interaction (Chaiklin & Lave, 1996; Gauvain, 2001). Both Betty and Cathy benefited from this exchange. Note the similarity between how Betty made this connection and those she expected her students to make when learning something new.

After this planning session, Betty commented on the dialogue between her and Cathy: "It is a constant back and forth. In fact, when you ask me 'Is this something new that Cathy has done?' I have a hard time instantly answering. I have to stop and go back to where did all this come from, and think about the exchange that brought us up to the activity that we are using, and what part of it she did provide, and what part we did together, and what part I had done. It all blends, which is nice. It's not me teaching her. No, it is genuine dialogue between two professionals. We didn't know how the activity would go. We both figured it out and we worked it through together. By the third time, it had changed drastically. The next teacher I am sure will evolve it even further. So we will

have a good activity when we get done" (Interview with Betty, 2/22/2001). Cavazos (2001) suggests that care, concern, and connection are important to teacher dialogue of this nature. Dialogue is distinguished from talk, narrative, and conversation in that it is directed toward discovery and new understanding, where the participants question, analyze, and critique the topic or experience.

Cathy believed her input in this and other dialogues was valuable to Betty. "I'm probably giving her another way to look at it. Getting my way and the students responses is helpful to her. Since she has been teaching it for so many years, it might be harder for her to take a step back and see other ways to do it. Her interns have a new, fresh look at things and maybe they were taught it differently in school, or our experiences bring in different ideas for how to teach it. The way I explain it is different than her way. Being closer to being a student might help me remember the way I was taught and what worked and what didn't" (Interview with Cathy, 3/8/2001).

Collecting and using empirical data to develop new ideas and strategies. Betty was anxious to try this activity. Not because she had never done this lab before, but because she had not done this particular activity with this group of students. She saw each group of students as different and their interaction with the subject matter as different. Thus, teaching was always new to her. Her central focus was on student understanding of the subject matter.

Eleven days after this planning session, Cathy taught the lesson to her second hour genetics class. It did not go smoothly. There was some confusion on the students' part as to what they were actually looking at in the microscope slide. Betty stated that she expected this since activities rarely run as well as a teacher hopes the first time through.

Thus, she saw the need to have multiple teachers teach the same activity so that it could evolve or "have the bugs worked out of it."

During the lesson, Betty entered the classroom from the back storage room area where she kept a desk. She said that she listened to the proceedings of the class from there while she was doing some work. She could easily hear Cathy's voice because she projected well, but she couldn't always hear the students' responses. When this happened and she was interested in hearing what was going on during the lesson, she went into the classroom and sat at the computer in the front of the room. She did some work while listening to the discourse in the classroom. "I couldn't hear where the problems were, and I wanted to hear them so we could talk about it, and get her perception and my perception both. I think it is better if we both have our views about class. So I wanted to get out there and see what the kids were doing, what kinds of problems they were having" (Interview after the lesson, 2/20/2001). This was one of the ways in which she collected data to address her researchable question.

What Betty was paying attention to during her classroom observations was student learning. This fit in well with the mission of the school and the science department, and her own deep-seated belief that a teacher's primary role is to help students learn. Betty was concerned with how students would interact with this activity. She knew that the timing of the activity had to be such that students were ready to understand the concept being presented. She based her decision about timing on her prior teaching experience, but also listened carefully to student questions and comments during the activity. These questions and comments were used in her subsequent conversations

with Cathy, and the results of these conversations were used to influence future teaching practices.

After the students completed the activity, the next step in the plan was to have Betty's independent study student (another human resource with knowledge and interest in genetics) collect the data from Betty's and Cathy's classes, plus data from the classes of other biology teachers. There were three other teachers teaching this topic, and they all wanted to try this activity as well. The results of the implementation of this activity in each classroom were shared, which informed the teaching of this concept in subsequent units.

The fact that the other biology teachers wanted to try this activity showed that they knew what Betty was doing. In other words, Betty had deprivatized her practice (to borrow Newmann & Associates' term) by sharing her ideas and Cathy's and her work. As was noted earlier, this was a common occurrence in this department. The teachers' interest also provided some evidence that they had shared values, namely helping students learn with understanding. Deprivatized practice and shared values were also crucial aspects of Betty's and Cathy's interactions and of the work of students in many class activities.

Multiple examples and a continuing search for better solutions. After this same lesson was taught to the fourth hour class, Cathy and Betty discussed the activity during their prep period. They focused their discussion not on the procedural aspects of the activity, but instead on student learning. This discussion helped them to understand that the students were struggling with a conceptual feature of the activity.

Betty: When we did it the first time, she [Cathy] was expecting them to do two things as one. We saw them as one thing. We found out if we separated out what the students were doing into two different things, one could be a stepping stone for the other, more of a scaffolding. The first one was a little easier. By being able to accomplish that, they were better prepared to work on the second one.

Interviewer: What were these two things?

Betty: We wanted them to look at a slide. Find cells that were dividing. Count cells as dividing or not dividing. Going through mitosis, not going through mitosis. Then sketch them. Then figure out the steps, in order, for mitosis. They were too confused, in doing all of that at once. For second hour, they went through and decided if the cell was in mitosis or not. Then they turned those data in. Then find the cells and sketch them. So they had learned how to find the cells. That was the task they had to learn how to do. Once they could identify cells, then they could look at them more closely and figure out what they were doing. There were more steps there in the learning than what we had thought. That's always been a problem. But it seems to have gone very well. I'm real happy. Another teacher is trying it, so we will hear from her. (Interview with Betty, 2/22/2001)

Thus, this discussion helped them to realize that two activities were needed where only one was planned and enacted. The next time this concept is taught, separating these two conceptual pieces will be an important part of the teaching activities. A realization such as this is particularly important in courses with sophisticated subject matter, like the elective genetics course Betty taught.

Betty's Learning Outcomes – Occasion One: The Mitosis Lab

Learning outcome. Betty now has another teaching strategy at her disposal to address the student misconception that "all cells do is divide." This has been a legitimate concern in her teaching. It was something that she had seen standing in the way of students developing a scientifically accepted and deeper understanding of cell functions in the past. The activity put forth by Cathy and further developed through their collective work enhanced her approach to teaching this part of the curriculum.

The influence of Betty's personal factors. One of the purposes Betty had for participating in the internship program was to present a challenge to her intern that would advance her own teaching and help her intern and students learn. She had done this repeatedly in the past with other interns. This helped Betty address legitimate concerns that she had identified in her teaching or in the curriculum. Thus, one of the purposes of the internship that Betty held was the belief that her own teaching practice should be enhanced due to being a mentor to an intern. This belief is not held by all mentor teachers. But Betty took this belief one step further, she acted on it. By providing the intern with a challenge, Betty found a way to focus an activity that resulted in enhanced teaching practices for both the intern and herself.

The influence of the norms of the science department. The science department played a crucial role in this learning outcome for Betty. A number of the science teachers tried this activity after Cathy taught it, and they shared their results. Using this activity in multiple classrooms with a variety of student groups and then analyzing the outcomes from these experiences provided further adaptations that could be made to improve the activity. By sharing the results, the curriculum evolved more quickly (since Betty did not

have to wait a year for this part of the curriculum to be taught again in her own classroom) with the input of many teachers and student responses. The new, refined activity also became a resource that could be utilized by the entire science department.

Occasion Two: Reflective Dialogue Between Betty and Her Intern - Developing Test Questions

The previous occasion for learning was rather complex. It took place over a couple of weeks and involved not only Betty and her intern, but also other science teachers in the department as well. Since not all occasions for learning are that complex, let us see if the strategy for learning Betty used in the first occasion for learning can be applied to a less complicated occasion.

Creating an atmosphere of mutual trust and constructive criticism. The trust between Betty and Cathy that was described in the previous occasion for learning existed here as well. This trust made it possible for Betty to ask Cathy to do something potentially risky - act as a pilot participant for a genetics test that Betty had just designed and possibly reveal gaps in her understanding. Due to Cathy's experience with teaching at the post-secondary level (an experience Betty shared), Betty hoped to have in-depth conversations that compared and contrasted assessments in science teaching at the two levels. Betty might very well have hoped that these conversations would reveal applications of assessment that she hadn't thought of to use at the high school level, but would help to enhance her practice.

Locating and utilizing relevant human and material resources. Reflecting on her prior experiences, Betty realized she needed to know what students were thinking in order to assist with the development of connections to new knowledge. It was important

for her teaching cycle to use assessment instruments that allowed her a window into how a student was making sense of the subject matter. This required an element of complexity to the problems on an assessment. True/false, multiple choice, and matching type questions would not give her the necessary kinds of responses. Problems related to real-life scenarios with multiple variables were needed. In order to comprehend her students' understanding, short answer, essay, and analytic problems dominated her exams. Some of the problems from prior exams acted as the seeds for newly designed problems. Learning with understanding is a complex activity, and Betty believed that a more complicated exam (along with frequent informal assessments) was needed to adequately assess this complex activity. This belief parallels that which is put forth in the literature (White & Gunstone, 1992; Wiggins & McTigue, 1998). Given that these were complicated to create, some feedback from a knowledgeable individual and reflection on the questions posed on the assessment were necessary. Many variables were involved in the problems and questions Betty designed for her exams. There was room for error, in either providing too little information to solve the problem or inaccurate information.

Reliance on carefully formulated researchable questions. Betty believed she needed to "know what her students are thinking in order to help them learn." Only by understanding the students' prior knowledge could Betty help them make connections to new knowledge. Her formal assessments were one way in which Betty could build her understanding of the students' prior knowledge and the connections they were making.

The problems on Betty's assessments required students to make a series of conceptual links. By closely examining the responses, Betty could ascertain where students were having difficulty in developing a solid understanding of a particular

concept. Thus, it was imperative that her formal assessments clearly articulate situations (problems) that would generate the types of student responses that show Betty how students are making sense of new knowledge in relation to their prior understanding. So her researchable question was: If she used Cathy (who could be considered a knowledgeable student) to pilot the test, what would she notice about how Cathy approached specific problems that would help her make the questions more clear and elicit the responses she was hoping for? Cathy's feedback helped in constructing a more effective assessment instrument.

Scaffolded collaborative work on problems. In one such case, Cathy took a copy of the Genetics II test and responded to the questions. She had her notebook out and responded to the questions in it. Betty did the problems as well. She watched Cathy as she did the problems to see how she approached them (Notes from a meeting between Betty and Cathy, 2/22/2001).

Engaging in this activity assisted Betty with the development of her assessments since Cathy was acting as a knowledgeable student who was taking the test ahead of time. Cathy knew the subject matter well and understood some things about developing effective assessments. Thus, the discussion that ensued after Cathy finished the exam involved two informed individuals.

> Betty: I noticed it took you a while to come up with an answer to number 3. How come? I thought it was rather straightforward.
>
> Cathy: Well, I didn't know. I mean, I know how I would have responded if I was taking this test, but the students don't have my experience. So I was thinking about how they would respond. If I think of fourth hour, I think they could write a

rather complete answer because we talked about this kind of question in class. Adam raised it last week. But if I think about second hour, I really think they would struggle. I mean some of the brighter students might be able to answer this, but a lot of them wouldn't write much.

Betty: You think they wouldn't get it.

Cathy: No, I wonder. What if we gave them a data table and asked them to interpret it? Then everyone would be working off of the same common data and we could see how well they applied what we taught them to a specific situation.

Betty: Now that's interesting. I never thought of that. Maybe we could use the data that was in one of the extension problems.

Cathy: That might work. Which one are you thinking about?

Betty: Well, the sickle-cell anemia one might work or the hemophilia one. I would want one that would require the use of lots of the ideas we worked with. Maybe the hemophilia one would be better.

In Betty's explanations to questions Cathy raised about the assessment, she made her thinking visible to Cathy (sickle-cell anemia problem or hemophilia?), and it was a reflective experience for Betty (how could data be used to develop a better problem?). This helped Betty re-work her subject matter knowledge (does sickle-cell anemia or hemophilia have more of the ideas that were discussed in class associated with it?) and helped her in the assessment of her students (by developing a more effective problem). In addition, Cathy was knowledgeable about the students who would be taking the exam. She could think of particular types of students who may respond to certain problems on the assessment in unintended ways. Therefore, Cathy was a very valuable resource to

Betty in the development of this assessment and in making instruction more-individualized for her students.

Collecting and using empirical data to develop new ideas and strategies. When asked about what she hoped to gain from having Cathy do the problems on the assessment, Betty replied, "I wanted to see where it might be awkward, by her going through it. We do that with each other's tests. We go through and, if it's not clear, you know how when you write something and it's clear to you, but it might not be clear to someone else? That happens to me a lot. I wanted her to take a look at it, where there was awkwardness, something like that. The way I word things sometimes, students might think I am asking something other than what I want to be asking. Or it might not be scaffolded enough to get the response I want because they need more explanation. How would someone else interpret my words? If she gives me what I am looking for by telling me what she thinks I am asking, then I know the question is probably alright" (Interview with Betty, 2/23/2001). Sharing an assessment that was just developed and asking for feedback was a common example of how teachers collaborated in the science department.

By observing Cathy taking the exam, Betty was learning about what Cathy paid attention to. She also closely inspected the procedures Cathy used in each part of the assessment, which allowed for a comparison to Betty's anticipated student procedures. For example, Betty was surprised how Cathy solved one of the problems. The procedure Cathy used was similar, but not identical, to the procedure Betty had used to solve the same problem. Cathy explained that one of her genetics professors had taught her how to do this procedure, and it seemed to work. Betty was intrigued by this alternate procedure and tried it herself. She came up with the same solution to the problem as Cathy (Notes

from a meeting between Betty and Cathy, 2/22/2001). So now Betty had another procedure at her disposal. In the future if a student in her class was struggling to figure out a similar problem, explaining the procedure Cathy used might make sense to this student.

Betty also listened closely to Cathy's questions about specific problems on the exam. For example, Cathy asked Betty, "Why did you give them this information? Isn't this telling them too much? It might give away the answer." In another instance, Cathy asked, "Can we make the assumption that the parents were heterozygous? Because if we can't, then this answer makes no sense" (Notes from a meeting between Betty and Cathy, 2/22/2001).

These questions were a window into Cathy's confusion and thought processes as she responded to exam questions. By reflecting on how Cathy responded to the problems on the exam, Betty better understood if the questions she was asking would provide the quantity and quality of responses that would be helpful in her ascertaining the progress students were making towards understanding the relevant concepts and theories. The questions Cathy asked during her taking of the exam also provided an opportunity for Betty to reflect on the development of the assessment. Cathy might interpret a question in a particular way that was unintended by Betty. The questions she asked brought these interpretations to the surface, and Betty had the chance to reflect on how Cathy's interpretation compared to her intention for the problem. This also provided Betty the opportunity to reflect upon the nature and amount of information provided for the students in the problems.

Multiple examples and a continuing search for better solutions. Since learning for understanding is a complicated process, assessments need to have an element of sophistication as well, so Betty needed to have a discussion with a knowledgeable other to see if her assessment was constructed so that the students were not set up to fail. Betty wanted her students to be successful. She needed to check if the variables she was giving them were supportive or complicating and if she had given enough information for the students to solve the problem. Cathy was helpful here. The results of their discussion about this set of problems/questions on the assessment led to another set of problems/questions. These were based on a range of variables that Cathy noticed were not a part of the current problems, but are important to student understanding.

Betty's Learning Outcomes – Occasion Two: Developing Test Questions

Learning outcome. Betty used Cathy to find ways of refining her formal assessment by developing strategies for more clearly asking questions for her intended purposes. Cathy's feedback was based, at least in part, on her prediction of how students would respond to this assessment. This was helpful for Betty's determination of how students are making connections among concepts and ideas. By determining where Cathy was having difficulties interpreting the wording of a problem and making this clearer, Betty improved her chances that students would provide the kind of responses she hoped for (those that expose student reasoning in relation to a specific set of circumstances). She also found out which problems were missing important variables, and they developed new test problems together based on areas of the subject matter Cathy noticed were absent.

The influence of Betty's personal factors. Since Cathy had experience in working on scientific research that Betty lacked and Cathy also had teaching experience at the university level (an experience that Betty shared), Betty had an expectation that she could learn from Cathy. Cathy brought a different perspective on teaching and the genetics curriculum to the internship. By carefully watching Cathy complete the questions on the assessment, Betty observed a different approach to solving the problems. Cathy's approach was an informed approach in that she understood the subject matter well, and she also had some understanding of effective assessments. Cathy was displaying these understandings while completing questions on the assessment. Betty's observations along with the discussion that ensued had their basis in Betty's expectation that Cathy's experiences and differing views could assist in the enhancement of Betty's assessment practices.

The influence of the norms of the science department. Betty was familiar with the practice of working with others in developing assessments. This was something that had occurred in the science department of Heisenberg High School for many years. Thus, the practice of having another teacher review at least a piece of an assessment instrument and related discussions were nothing new to Betty. The added benefit of having Cathy be the one to assisted in this task was that Cathy knew the set of students who would be taking the assessment better than another science teacher in the department would. Therefore, Cathy's prediction of how a student might respond to a problem was of particular value to Betty.

Conclusions

Betty expressed characteristics similar to those teachers who engage in generative growth. According to Loef Franke, Carpenter, Levi, & Fennema (2001) teachers engaged in generative growth (a) view children's thinking as central, (b) possess detailed knowledge about children's thinking, (c) discuss frameworks for characterizing the development of children's thinking, (d) perceive themselves as creating and elaborating their own knowledge about children's thinking, and (e) seek colleagues who possess knowledge about children's thinking for support. While this was a study of the professional development of mathematics teachers, it can be argued that data included in this chapter are consistent with, at least to some extent, these characteristics.

The Interrelatedness of the Planes

Based on the examination of the three planes from the conceptual framework, a summary table was constructed showing how each element of the strategy Betty used in the occasions for learning is related to aspects of each of the other two planes. It seems that the strategy she used for mentor teacher learning is adapted from her personal factors (namely her teaching practice), which are related to the context that exists at Heisenberg High School.

Table 7

The Relationship Among the Context, Personal Factors, and Betty's Learning Strategy

Characteristic	Context	Personal factors	Activities
Mutual trust and constructive criticism (Social environment)	Critical colleagueship with a subset of science teachers Technical language from the teacher education program	Betty created situations that helped her students work together productively Students critically examined each others' work	Betty and Cathy bared their souls to each other Ways of communicating with an intern are different than with students or peers
Locating and utilizing relevant human and material resources (Resource use)	Ample material resources in the science department Teachers have a variety of experiences and knowledge	Solid background in subject matter knowledge Adept at finding ways to incorporate multiple resources into her teaching	Cathy and materials from prior activities were used in developing a new teaching strategy Cathy and the way she responded to problems are used to improve an assessment
Formulating researchable questions (Defining tasks)	Many interactions within the science department centered on researchable questions	Many student activities were designed around researchable question	Addressing a student misconception Designing ways to make student thinking and reasoning visible

Table 7 (cont'd)

Characteristic	Context	Personal factors	Activities
Scaffolded collaborative work on problems (Learning process)	Sharing of ideas and resources in the science department Other science teachers were human resources	Students worked together on meaningful tasks Students used the ideas and practices of others as human resources	Betty and Cathy worked together to design activities and assessments, relying on each others' strengths and differing perspectives
Collecting and using empirical data to develop new ideas and strategies (Learning process)	Multiple teachers used activities in their classroom and compared results	Students generated data during activities that were interpreted in small groups	Data from the mitosis lab were collected and analyzed to further modify the approach used to address the misconception Carefully observing Cathy do the problems identified strengths and weaknesses that were used to modify the assessment
Multiple examples and a continuing search for better solutions (Nature of a satisfactory conclusion)	Resource rich environment Science teachers constantly strove to improve their teaching practices	Teaching for understanding is complex, so many examples and approaches were needed to help all students, not just those who catch on quickly	Betty needed to continue to find new activities that helped students make sense of key ideas and concepts Betty needed to continue to develop carefully designed assessments that would provide valid and useful data about student learning and her teaching

It is important to note that different data sources were used to establish the contents of each column. The examples in the "Context" column primarily came from interviews conducted with teachers in the science department and observations of informal gatherings. The examples in the "Personal Factors" column largely came from interviews with Betty, asking her clarifying questions after an activity, and observations of her teaching lessons. The examples in the "Activities" column came primarily from observations made during interactions between Betty and Cathy. Thus, strength is added to the claim that the characteristics listed in the first column are the important ones to pay attention to concerning Betty's learning strategy when responding to an occasion for learning since they are common among a wide range of data sources.

It is also important to remember that Betty had been a mentor teacher many times before working with Cathy. Betty's role in the occasions for learning was informed by these prior experiences. She possessed effective ways of communicating with someone who is learning to teach and establishing a conducive environment for both her and her intern's learning. She was adept at identifying and utilizing important resources that assisted with the carefully thought-out researchable questions she had developed. She was also skillful in scaffolding interactions between her and her intern that relied upon relevant data, a careful analysis, and reasonable interpretations. All of this was done in an effort to improve her teaching practice and help her intern develop patterns of practice that would lead to effective science teaching.

Summary of the Chapter

This chapter presented the story of Betty's learning from the experience of being a mentor teacher. Discussion concerned not only what was learned, but also how learning

took place by taking into account the context, Betty's personal factors, and the learning strategy she employed during two occasions for learning.

There was a tradition at Heisenberg High School of collaborative work among teachers, including cooperation and mutual constructive criticism around issues of teaching and learning for at least a subset of the science teachers. The school's focus was on teaching and learning. A rich supply of material resources and a department wide use of the university's teacher education framework and vocabulary were also important parts of this context.

Betty's teaching practices emphasized collaborative work around researchable questions that demanded extensive knowledge and careful planning. This served as a model for how she approached teacher learning (establishing a conducive social environment and utilizing appropriate strategies). A key feature was generating researchable questions for teacher learning. Her theory of learning applied equally well for both student learning, intern learning, and her own learning.

The activities that were the focus of this chapter were two occasions for learning. The first was the creation and implementation of a mitosis lab to address a student misconception while the other dealt with the development of a student assessment. In each occasion for learning, Betty utilized the same strategy for learning, as stated below. This strategy is related to both her personal factors and the context of Heisenberg High School:

- Creating an atmosphere of mutual trust and constructive criticism
- Reliance on carefully formulated researchable questions
- Locating and utilizing relevant human and material resources

- Collecting and using empirical data to develop new ideas and strategies
- Scaffolded collaborative work on problems
- Multiple examples and a continuing search for better solutions.

Chapter 4: The Story of Donald McMaster

Overview of the Chapter

A Focus on the Larger Learning Community and Context: The School, the Science Department, and the Teacher Education Program

- The school
  - A focus on responsibility and "getting along"
  - Science course requirements
  - Other district policies and procedures
- Norms of the science department
- The teacher education program
- Key aspects of the context that will be reflected in the occasions for learning

A Focus on Learners and Purposes: The Effect of Personal Factors

- Donald's philosophies of teaching and learning
- The nature of Donald's teaching practices: Planning, teaching, assessment, and reflection
- Key aspects of the personal factors that will be reflected in the occasions for learning

A Focus on the Local Learning Community and Activities: Two Occasions for Learning

- The identification of "What" is to be learned
- Occasion one: Using time freed up by the intern's teaching – Creating an alternative teaching strategy for Advanced Placement Physics
  - Mutual respect and getting along
  - Continuing search for new resources
  - Using the textbook and self
  - Learning about what works through individual active processing

Engaging in assigned responsibilities

Learning outcomes

Occasion two: Teaching earth science for understanding

Mutual respect and getting along

Engaging in assigned responsibilities

Learning about what works through individual active processing

Using the textbook and self

Continuing search for new resources

Learning outcomes

Conclusions

The interrelatedness of the planes

Donald's learning outcomes

Summary of the Chapter

Overview of the Chapter

Once again in this chapter, the conceptual framework from Chapter One is used to examine occasions for learning. In this case, they are the experiences of Donald McMaster, the second focus mentor teacher in this study. This was Donald's first experience working as a mentor to an intern. The three "planes of focus" are utilized to help us understand any learning about the teaching cycle that took place on Donald's part during the internship.

Like the previous chapter, this chapter is organized from the broadest plane to the most narrow. Thus, a discussion of the context of Einstein High School, the science department, and the university's teacher education program begin this chapter. This sets the overall situation where Donald's learning takes place along with examining important characteristics that will play a role in investigating the occasions for learning.

The next section (related to the second plane) acts as an introduction to Donald by concentrating on his personal factors. This includes a discussion of his teaching and learning philosophies and a look at his teaching practices. This also includes a discussion of his planning, teaching, assessment, and reflection activities and how his personal factors affect the characteristics that will be used to examine the occasions for learning.

The final plane of focus is an analysis of the activities in which Donald engaged. Two specific occasions for learning are discussed. The first deals with Donald's use of the time freed up when Doug, his intern, is teaching the earth science course. Donald chose to use this time to work on developing a new teaching strategy for his AP Physics course. The other occasion for learning occurred when Doug asked for Donald's help with an earth science teaching problem. An examination using the characteristics related

to Donald's personal factors and the context of Einstein High School provides an interesting analysis.

The conclusion to this chapter examines the interrelatedness of the three planes of focus, and it examines the "what" question in this study: What were Donald's learning outcomes from these occasions for learning? A discussion of the parts of the teaching cycle that were enhanced due to participation in the occasions for learning is presented, along with the relationship to the personal factors plane and the context plane.

A Focus on the Larger Learning Community and Context: The School, the Science Department, and the Teacher Education Program

The School

Einstein High School was opened in 1928. It is a large three story, brick building that is near the center of a mid-sized city in the Midwest. Einstein is one of three high schools in this district, and it played host to approximately four science interns from the local university each year along with a number of interns from other subject matters. Since it has been in existence for more than seven decades, many of the parents of the current students are alumni. According to one interviewed teacher, these parents have a memory of what education in this building looked like in the past and expect it to be similar now.

The student population of Einstein High School was diverse. In every class I observed at least half of the students were minorities. Asian Americans, African Americans, Hispanics, and Eastern Europeans made up significant portions of the students. Some of these students were new to the United States and had limited proficiency in English. A variety of backgrounds and beliefs were represented at this

school, and some of those interviewed felt students needed to learn to respect varying perspectives.

Material resources were scarce at the school, except for textbooks and their related resources (e.g., worksheets, practice tests, chapter exams, laboratory procedures). Each room had a current set of textbooks, and many of them had books from the prior set saved as well. The budget was tight. The school had limited funds for teachers to purchase supplies and equipment, other than what had been budgeted from the previous year. The procedures to be completed for accessing these funds were complicated and time consuming.

A focus on responsibility and "getting along". The mission statement for the school, which was prominently displayed in many classrooms, stated that Einstein High School will provide an emotional, physical, social, safe, and stable environment that will: (a) enable students and staff to value and respect themselves and others; (b) enhance responsibility, accountability, and a positive attitude toward each other; (c) facilitate connections between the learning process, the student body, and the environment in which they exist; and (d) cultivate cooperation between students, staff, and the community to produce a healthy and productive society.

It is interesting to note that value, respect, responsibility, accountability, and a positive attitude are mentioned in this statement before the learning process. This mission statement focused on interpersonal relationships and the ways in which pieces of the educational community were to relate to one another. When student learning was mentioned, it was with respect to the connections that were to be made between the

learning process and two other elements of the school, the student body and the environment.

A focus on "getting along" and "being responsible" permeated this environment. This was evident in examining the posters that hung in the hallways and the classrooms:

- 3 R's – Respect Yourself; Respect Others; Respect Your School.
- Welcome to Einstein's Year of Responsibility.
- Your life isn't the only one on the line when you choose to drink and drive.
- Be Healthy – Energize with Exercise; Snooze...Don't Lose; Devour for Power...Eat Healthy; Breakfast...Jump Start Your Day.

Very few posters concerning student learning or any subject matter were present. When they were, more times than not they reminded students to be responsible for their learning by coming prepared to class (i.e., having a pencil, paper, textbook, etc.). Interruptions during lessons were very common. I observed lessons on twelve occasions. Each time there was at least one interruption: There would be a phone call for Donald or a student, workers would show up to fix a window, a secretary would stop by the classroom to give Donald a message, etc. From all of this, one possible implicit message to students was that other concerns take precedent over the concentrated effort associated with learning.

Science course requirements. Students needed to complete three years of science to graduate, but no specific courses were required. Freshmen did not have to take any science if they did not want to. For example, a student could start with chemistry as a sophomore, take physics as a junior, and then AP Physics as a senior. However, physics was not a pre-requisite for enrolling in AP Physics.

Earth science, one of the courses Donald taught along with introductory physics and AP Physics, was only a recommended course. The more academically successful students generally took biology as freshmen. According to Donald, parents wanted the earth science course to be optional because they perceived earth science to be a lower track class. They put enough pressure on the administration that it was decided earth science would only be a recommended course. "It's tracked. That is probably the worst thing that we are doing with our students because of the fact that when we track we basically say to a certain segment, 'You're not valued. You're in this class that, you're just basically in a blow-off class, or it's a class where you are considered sub-students almost.' They know the kids who are, either the parents are speaking up or the kids with the higher GPA are taking biology. These kids kind of feed off each other and they feel, 'Okay we are all a bunch of whatever, losers or what not', and they're not. It's problematic" (Interview with Donald, 4/26/2001).

Tracking is a prevalent practice in many schools that groups students of similar characteristics (such as academic ability) together for instruction. Some have objected to this practice stating that tracking allows schools to practice in-school segregation and perpetuate unequal opportunities and unequal socialization within classrooms (Black, 1992). While others feel that some form of tracking is inevitable and suggest that in order for it to be beneficial, teachers need to reassess grouping assignments frequently, vary instructional levels and pace, assign groups based on demonstrated needs and abilities, group students for only one or two subjects, and use ability groups to teach specific skills (Hereford, 1993). Whatever the viewpoint, tracking was practiced at Einstein High School in most subject matter disciplines.

Other district policies and procedures. Pacing guides and quarterly assessments were being implemented district-wide. According to the pacing guide, earth science teachers should teach nine weeks of weather, nine weeks of astronomy, and then nine weeks of plate tectonics. The teacher was given latitude during the last nine weeks to teach what seemed necessary.

While pacing guides and quarterly assessments were provided by the district, some policies made it difficult for teachers to procure needed classroom materials and teaching supplies. During my first observation of Donald teaching an introductory physics lesson, I noticed he purchased yo-yo's at a local store and had photocopying done at Kinko's.

> "As a teacher what happens is that, it would be nice in an ideal world where everything was supplied to you and you would be able to get it and get reimbursed quickly or if you needed some on-the-spot copying you could be able to do that. I just so happen to have a printer problem so the ink cartridge is not working. I replaced it. It still wasn't working, but my way is not to be impeded by that kind of scenario. I will do what it takes, and in this case it takes going to Kinko's and getting the copies for the lab so that way students have something to work on. If it takes the yo-yo's because I didn't really have yo-yo's before. So as a result, I asked students to bring in yo-yo's which you saw some of them did. But I also anticipate some may not, and so as a result there was, believe it or not, it was really hard at [the local store] to be able to locate yo-yo's because it is a summer type of toy. They are just now bringing those on board. I always either take it upon myself that if I need something to make a lab successful, I will do it. I

will go out and get it myself." He has it as a write-off for his taxes, but "it's more that I want to make sure that the kids have the materials to be successful. So you can see a lot of materials back here that I just go out and buy on the spur of the moment."

Interviewer: "And do you get reimbursed from the district?"

Donald: "No. I probably could, but I think that most teachers feel that process is such a pain. You got to fill out this paperwork. You got to put in for a request and so on and then you may not get it at all for a long, long time. It's something that I figure that teachers take a hit on. They will go out and get supplies" (Interview with Donald, 2/8/2001).

Supplies and other material resource shortages occurred at Einstein High School, particularly during the spring semester when inventories were near depletion and budgets spent. This is similar to other schools in urban districts, like those described in Jonathan Kozol's (1991) *Savage Inequalities*.

Norms of the Science Department

There are approximately seventeen sections of earth science taught by five different teachers at Einstein High School. However, none of these teachers had an earth science major, and no one was state certified in earth science. The teachers were spread throughout the building, from floor one to floor three. "It does make it tougher [to collaborate]. The numbers of teachers teaching it and the physical distance does make it tougher" (Interview with Amy, 5/24/2001).

Monthly department meetings did not seem to open up many lines of communication among the science teachers since there was little time set aside for

individual teachers to share their practices or questions and concerns. According to the science interns, the science department chair set the agenda, and it was closely followed. During the time when data were being collected, much of the discussion concerned the decision of which textbooks to adopt for the next school year. In addition, logistical procedures (new policies, paperwork that needed to be completed, information that needed to be disseminated) took up most of the remaining meeting time (Interview with the Einstein interns, 4/13/2001).

This type of faculty meeting was also prevalent in the schools Cusick (1992) studied. He reported that each of his three schools had an approved curriculum, department chairpersons, and department meetings, just as Einstein had. In all of these schools, none of these people or events could offset the teachers' personal approach to subjects and students. Department meetings were not designed to make decisions about common activities as much as they were to ensure that one teacher's established practices did not interfere with another's. In *Contradictions of Control*, McNeil (1986) reported similar autonomy and similar distance among faculty members in the four high schools in which her study was based.

When asked if he was able to talk with other earth science teachers, Donald responded, "Not as much as I would like to." Donald cited two reasons for this – Some of the teachers would be reluctant to share because they were not too comfortable in their area. This means they didn't have the subject matter knowledge, and they didn't want to be seen as being wrong or not being intelligent in front of their colleagues. This was an important issue for these teachers. A lack of subject matter knowledge made the teachers hesitant to get together and talk about issues surrounding the teaching of earth science.

The other reason that he gave was that the teachers would be too territorial. If they developed an activity or a test, then it was their own. Some of them felt reluctant to share because they "give and give and give and never get back anything that is worthwhile" (like another activity or test) to them. He said that had happened to him in the past as well (Notes from a debriefing with Donald, 3/9/2001). According to Doug (Donald's earth science intern), "Donald and I talked about something that he liked that a different earth science teacher did and when he asked to see it, the guy was hesitant. He was going, 'I don't know.' To me, that's not teamwork" (Interview with Doug, 4/10/2001).

A pervading sense of being able to "do your own thing" and teaching in a manner that was comfortable to the individual teacher filled this department. It was seen as one of the benefits of being a teacher at Einstein, and thus many of the teachers worked on developing their own teaching practices independently, even if another science teacher was right across the hall, and they had the same prep period. This was the case with the two chemistry teachers. According to Michael, a chemistry intern who worked with Amy, "There are two chemistry teachers at Einstein. They both have very different styles of teaching. They know that. They just let it be that way. They interact in a friendship sense, but they don't talk about, 'I did this demo. It really worked well.'" Michael saw them both as dedicated teachers. "I think they are just comfortable with their teaching styles and that's what they do." Roy used lots of demos and good lectures based on material from the textbook, and Amy used lots of group work and labs that were also closely related to the textbook (Interview with the Einstein interns, 4/13/2001).

This type of structure and the related practices of infrequent communication and little collaboration around issues of teaching and learning are common in many schools.

Cusick (1992) argues that pressures exist that cause such structures and practices to make sense, not the least of which is the pressure to deflect criticism. "A system of self-contained classrooms and separated teachers may be less likely to generate criticism and better able to deflect criticism that arises. That is not to say that teachers do not cooperate. But it does say that the problem posed by crowds of students in dense and busy schools is best handled by assigning individual teachers to sets of students and by giving those teachers broad discretion. What teachers do with teachers is a distant second to what they do with students" (p. 76).

The Teacher Education Program

At Einstein High School, the university's teacher education program seemed to have an influence in one sphere, but not in another. Among the cohort of the four science interns, the norms of collaboration, teaching for understanding, and an intense focus on student learning espoused by the university's teacher education program took hold. According to the field instructor assigned to Einstein, the interns discussed classroom events and issues associated with student learning with each other. They were willing to share resources with each other and asked each other important questions concerning learning to teach science for understanding. They worked together on the final presentation for one of their graduate level Friday courses at the university, an activity I supervised since at the time I was a TE 804 instructor. For this presentation, they examined the context of the school and its influence on teaching practices.

However, these practices were not picked up by the faculty. According to the discussion during a group interview with the interns, instances of collaboration among the science faculty were rare. Mentor teachers would ask interns why they were bothering

to collaborate. The interns interpreted these queries by their mentors as legitimate since they felt that their mentor's perspective was that collaboration takes time and effort, and the rewards, if there are any, are not enough to warrant it. In addition, since most of the science department teachers relied heavily on using the textbook as their main resource for teaching, collaboration with peers took on less importance (Interview with the Einstein interns, 4/13/2001).

The mentor teachers might also have been wondering why one intern would ask other interns for help and guidance since this conflicts with the traditional view of learning to teach where the novice asks the experience mentor for assistance, not other novices. As Feiman-Nemser (1998) reports, the conventional approach sees mentors as experienced individuals who are "support providers" for teacher candidates. The support can include emotional and social help, along with assistance in learning to teach. In this view, one purpose of the internship is for the novice to tap into as much of the wisdom and experience possessed by the mentor as possible. This may leave a mentor wondering why other interns were being asked for advice instead of him or her.

What happens if an intern does not value the type of teaching he sees his mentor engaging in? Doug's attempted approach to teaching earth science for understanding was challenging for him. He was trying to implement some of the ideas and strategies put forth in his teacher education courses at the university. However, if things didn't go as planned, which they many times did not on the first try, he did not find the support he was hoping for from Donald. Donald taught earth science in a rather traditional manner (e.g., using the textbook as the primary resource, emphasis on vocabulary words, students spending time working on worksheets, etc.). However, he was taking an on-line master's

level course in teaching for understanding from the same department at the university. Therefore, the teacher education program was a potential influence in two ways – Doug believed in its approach to teaching science and was attempting to teach in this manner and Donald was enrolled in an on-line course that espoused teaching practices that were congruent with the teacher education program. Would these influences be enough to change Donald's earth science teaching practices, or would the individualized approach to teaching science and the reliance on textbook generated activities that pervaded the science department hold sway? We shall see in the section that discusses the occasions for learning during this internship.

Key Aspects of the Context That Will Be Reflected in the Occasions for Learning

Just as in the previous chapter, the context described thus far includes some important aspects that will be seen again in the discussion of Donald's personal factors and in the discussion of the two occasions for learning. These aspects include:

As in Ch 3, you might think about using the row headings from Table 9 to show the compare and contrast structure with Betty.

Mutual respect and "getting along". Each teacher taught in her or his own way and did her or his own thing. Teachers were shown respect by not having their teaching practices questioned by their peers, but instead agreeing that each teacher needed to teach in a way that was comfortable for him or her. Respecting one another was a major emphasis of the school's mission for student interactions as was getting along with one another.

Using the textbook and self. Other than pacing guides and textbooks, material resources were scarce at Einstein High School. Teachers did what it took to teach in their

way, meaning they might have to purchase supplies using their own money. Reimbursement procedures were cumbersome and time consuming. Science teachers were left to themselves to plan, teach, assess, and reflect. None of the science teachers had a major in earth science, and not one was state certified to teach in this subject matter. Donald was the only physics teacher at Einstein High School, so he must go outside the building to discuss the teaching of physics with a knowledgeable other.

Learning about what works through individual active processing. Teachers taught in their own way, so they learned about relevant teaching practices independently as well. Since each teacher had a different perspective and set of practices, sharing and collaborating on projects made little sense. As we shall see in the next section, the feedback Donald provided to less experienced teachers was used in a way that made sense to the individual teacher.

Engaging in assigned responsibilities. Students were to act in a responsible manner, completing activities and showing respect to teachers and each other. Teachers were to follow the district's pacing guides and administer quarterly assessments. In some cases in an effort to keep up, there was not time for students to develop deep and powerful understandings. Students were to complete the assessments. Since a significant portion of the assessment was multiple-choice questions, robust understandings were not required in order for the student to perform well.

Continuing search for new resources. From my interviews during data collection and observations as a field instructor at this school, it is fair to say that science teachers were continually looking for new resources. However, these resources needed to be

directly related to the topics in the pacing guide. Many times these resources took on the form of a new worksheet or other activity that the teachers could use on their own.

A Focus on Learners and Purposes: The Effect of Personal Factors

The same personal factors that influenced Betty's learning from the experience of being a mentor also influenced Donald. To review, these included beliefs, perceptions, behaviors, attitudes, and prior experiences. Like Betty, Donald also had a teacher frame that was used to help him make sense of the variety of occurrences in his classroom. His personal practice theory provided him support to respond to these occurrences. Once again, two important pieces of personal factors were Donald's philosophies of teaching and learning and the nature of his actual teaching practices.

Donald's Philosophies of Teaching and Learning

One of Donald's overarching philosophies was "If you care about your students, they will care about you" (Interview with Donald, 3/7/2001). Donald placed a lot of emphasis on developing good, positive relationships with his students. "At this point in time I can work with kids. You give me a student no matter in terms of general ability, fairly low ability, high ability, I can work with the student. I have a very good rapport with students" (Interview with Donald, 3/16/2001). He stood among his students when he taught. He expected them to treat each other with respect. As students entered the classroom, Donald was very friendly. He said, "Hello, how are you today?" and called many of them by name. The class was ethnically diverse. Donald smiled a lot. During the lesson, he patted students on the back. He used humor and trendy phrases like "I feel the need for speed" and he wasn't afraid to poke fun at himself, "I had a senior moment." He called his students "Scholars." To another student, he asked, "Hey, how did that speech

go?" A round of applause was given to a student who was a member of academic decathalon (Notes from an observation, 3/9/2001).

During one of my visits to his classroom, Donald wanted me to notice that he had the students put their jackets in the corner when they arrived. He did not allow them to wear headphones, and he did not allow them to eat in the classroom. No horseplay was allowed. He insisted students say "Please" and "Thank you". He didn't like it when students said "Shut Up," so he told them to say "Please be quiet." I asked him why these things were important to him. "The students need to have some structure and stability in the classroom. There has to be a comfort zone where they can learn. If it's too helter-skelter, too chaotic, the students might feel frightened or on edge, and that's not going to help them learn." However, he didn't want them to feel this was too strict or too controlling because that would not be good for their learning either. For example, he didn't want them to have to raise their hand to get out of their seat. He wanted to find a comfort zone for their learning.

This comfort zone is related to the stability of the environment. As Jackson (1990) observed, "When our young student enters school in the morning he is entering an environment with which he has become exceptionally familiar through prolonged exposure. Moreover, it is a fairly stable environment – one in which the physical objects, social relations, and major activities remain much the same from day to day, week to week, and even, in certain respects, from year to year" (p. 9). While Jackson was discussing the school as a whole, it seems as though Donald has a similar goal of establishing a stable environment in his classroom.

According to Donald, a conducive classroom environment must be created before meaningful instruction and learning can take place. I asked him about this one day after observing him teach two different hours of earth science class in two somewhat different ways. "With seventh hour, I wanted to get them more on task, make sure that things in terms of the environment. We're still at the classroom environment [stage]. Fifth hour, classroom environment is there, so I can work on the instruction. Making sure that the instruction is done. So each progression, as you can see, we're still trying to get them, seventh hour to make sure the classroom environment is in the learning environment" (Debriefing with Donald, 3/9/2001).

The importance of a conducive classroom environment to learning has been widely studied (Anderson & Walberg, 1974; Chavez, 1984; Fraser, 1981; Fraser, 1986), and Donald's views are consistent with many research findings. For example, Wilkie (2000) found students believe they learn best when the classroom environment has a high degree of teacher support, when it contains learning enhancement activities such as relating current material to real life, and when the environment contains responsible behavior.

Another indication of Donald's beliefs about teaching and learning is to note what he paid attention to when observing another teacher. I had the opportunity to sit in on discussions he had with Doug after observing him teach an earth science lesson and when he observed a novice teacher teach a lesson in an English class. Donald took notes during each lesson. These notes were events that occurred during the lesson in the classroom. Not too much attention was paid to student learning, but rather the notes were more procedural. For example, he took notes on who and how many times a student sharpened

a pencil, who was sleeping, who was talking, where the teacher stood, if students pushed one another, etc. Thus, student behavior was a central feature of what Donald paid attention to during a lesson. The questions Donald asked during the post-lesson conference also had a procedural flavor and were related to the resources students used: Do students keep folders? Where do you keep student papers? Are students able to turn back in papers for a better grade? How do you keep students on task? Does each student have a textbook?

The notes from his observation were given to the intern or novice teacher. No copies were made. Donald wanted the teacher to feel comfortable that these notes would not crop up in another situation. Therefore, the novice teacher's or intern's teaching practices were revealed to only the students during class and Donald during an observation. Donald provided feedback to the novice teacher and his intern, but felt that the feedback may or may not be acted upon. "They [the intern or novice teacher] are also like students. They are going to take whatever they want from the information that you're going to give and they are going to be able to process it in their own way" (Interview with Donald, 3/5/2001). Donald wanted to get his intern to be a learner. He wanted the intern to be self-directed.

Donald also wanted his students to become independent learners. Upon his arrival at Einstein High School, there were only two physics classes, but the next year there were three classes. His third year at this school (last year), he taught AP Physics. It was the first time this course had been taught at this school. He looked at it as a challenge. "Certainly, the way in which traditional AP classes are taught, I didn't know if that was really for me. So that is why I went towards more of the self-directed way. I feel that

maybe the first marking period, it would be me, getting them through the basics of the physics. My way of adapting it was to get them to take more ownership and then teaching them how to teach." Thus, Donald needed to find ways to help his students become self-directed learners.

According to Donald, in order to be self-directed students need to use resources and "process" information. I asked him how he was defining the term "processing." Donald responded, "Part of it is to just be able to, if you will, almost go through the Bloom's taxonomy. First, figure out the knowledge. Get some basic knowledge of the information of what you're studying or what you're presenting. Second is to trying to be able to see if you can develop or explain it. Third is if you can be able to apply it. Fourth is if you can be able to evaluate and so on. It's that spectrum. That processing takes time. It's so really hard for them to see. I've got all this stuff on this website or web unit. I should be able to know it. No, it's not going to be just lickedy-split. At first I thought they could go at their own pace, but then I found out that kids were not seemingly taking the time to process it, so I slowed down and literally induced this process time. That's that whole idea. Students need soak or marinate time. That is really important. You need to reflect on it. If they can't process it, it's no good. It's not their's. They don't know it. They don't understand it, or they're not even at that level where they can understand it" (Debriefing with Donald, 3/21/2001).

One interpretation of this perspective on individual processing of the subject matter means that there is little a teacher can do to control student learning. A teacher can present resources to a student, but it is up to him or her to "process" the information and make it her or his own. This is congruent with evidence from the literature. Analyzing,

reasoning, synthesizing, testing/debugging, and explaining are all aspects of students processing data in order to create a model of a system (Stratford, Krajcik, & Soloway, 1997), a model that is individual to the student.

This view might help us understand why Donald puts such great emphasis on developing positive relationships with his students and between the student and the subject matter. "I'm finding out as the years go by, if the kids end up liking the class or like me at the end of the year, I think I'm okay. I think most folks, if they come out of a class, they like the teacher and they like the class, they'll have some good memories about it. They'll want to go on" (Interview with Donald, 6/8/2001). In Donald's eyes, rapport was "priceless." "They know who you are. They know what to expect from you. And then probably, hopefully, is that I was able to teach them a little bit of science, along the way" (Interview with Donald, 6/8/2001). When asked how he wanted students to view science by the end of the school year, Donald responded, "Ideally, with a sense of 'Gee whiz,' 'Wow, there's a lot of neat stuff'. The other sense is 'Gee, I need to learn a lot more too'" (Interview with Donald, 6/8/2001).

The Nature of Donald's Teaching Practices

Even though Donald taught two different disciplines within the sciences in quite different ways, there were some underlying consistencies in his teaching practice. He encouraged student effort, but showed some reluctance to challenge students with really difficult intellectual questions. He put a lot of emphasis on student respect. The teaching cycle is used to explore Donald's teaching practices.

Planning. According to Doug and my own observations, Donald's teaching of earth science was textbook driven and very traditional with lots of notes, an emphasis on

vocabulary terms, readings from the chapter, students answering questions at the end of a section in writing, etc. Therefore, Donald's planning for a lesson consisted primarily of sequencing activities from the textbook in the proper order. He also felt the need to estimate how long it would take students to complete a task, since as he put it, if students were not busy, then behavior problems had the tendency to arise.

His planning was partly determined by what the school district said the curriculum was, through the use of the pacing guide. This told him he needed to "stay within these parameters" of the topics to be taught. In physics, he looked at the topics covered in the chapters of the physics text. He also looked for supplemental learning resources, but "my general guide is the book. We are trying to get to using pacing guides and quarterly assessments, so we [physics teachers in the district] look more and more alike. This has been done with the earth sciences course, including the creation of some activities" (Interview with Donald, 2/8/2001).

The use of pacing guides and other curricular supports for teachers was becoming a common practice in this district, particularly since frequent assessments were being used to hold teachers and students accountable. The pacing guides not only told teachers the topics to be covered during a nine-week period, but also when and how long to engage with a particular topic.

Donald spent a good amount of time planning for ways in which he could motivate his earth science students. When asked about this during a planning session Donald responded, "Teaching this stuff is not easy. It's not easy. Because you're going to find kids that, you saw just the motivational level. Unless something blows up, unless something happens where they are going 'Gee whiz,' they find themselves either bored,

or they find themselves not engaged. It's one of those things where, it's a lesson where not everything they're going to do is going to be always 'Gee whiz,' Bang', and so on. Part of this learning is tough stuff. That's why I tell the class, 'You're here because you want to be here.' I'm really, really, really emphasizing to these classes because if you don't want to be here, if this is like too boring for you or if this is something that you're just not enthused about what's going on, or you're not going to try, you're not doing yourself good or me any good. If they are here, they are implying I want to be here and I'm going to try. With the physics classes, I really don't have that many problems. For most of them, peer pressure is enough that they can get the other kids kind of motivated and get going" (5/18/2001).

Even though most of the activities in physics were planned around textbook resources, some small group activities and group projects were planned based on real world phenomena. For example, the introductory physics students worked on a writing project with a partner for a few weeks during the spring term. The focus was on center of gravity, and the topics included SUV's, track and field, and building design. Donald decided on the topics and generated questions for the students to use. One example of a question that was posed in one group's work was "Why do rollovers occur in SUV's?" Time in the library was reserved for students to work on their reports. Donald laid out the expectations for a good report and showed the students reports from previous years as models. However, students were pretty much on their own to complete this task. For example, the students were expected to schedule and conduct an interview with an engineer, professor, coach, or other professional in the evening or on a weekend.

Teaching. Donald's teaching practice placed a heavy emphasis on developing respectful relationships with his students and among the students. As he said, "Good rapport is priceless." The relationship between Donald and his students was related to the responsibilities each had. Diagrammatically, this relationship may look something like that depicted in Figure 3.

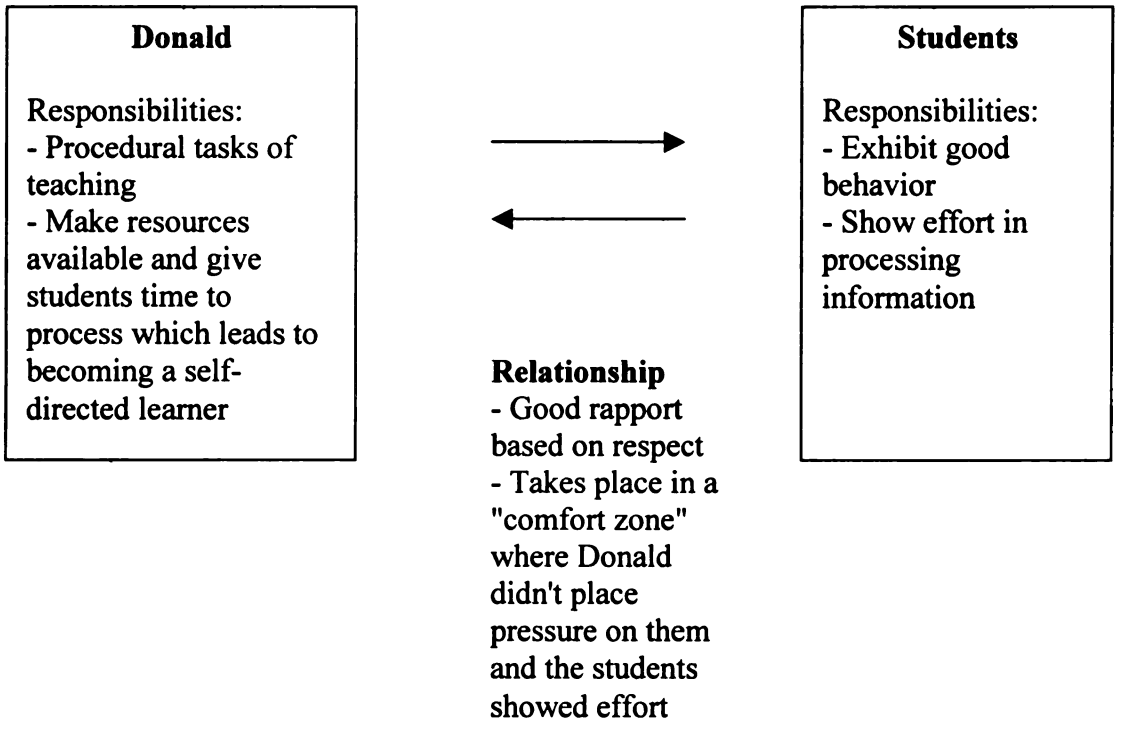


Figure 3.

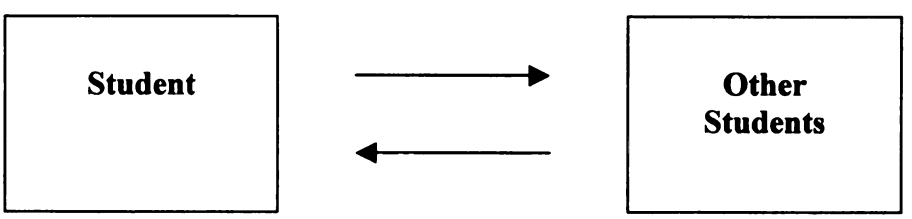
The relationship between Donald and his students was based on good rapport in a comfort zone that relied on everyone engaging in their responsibilities.

Donald's responsibilities included the procedural tasks of teaching, which include developing unambiguous tasks, organizing activities that were realistic, treating students fairly, etc. He also located and made available resources that students could use to "process" information which helped them become self-directed learners. Many of these

resources came from the textbook. In return, students were to exhibit good behavior, which included showing Donald respect and showing an effort in processing information.

As long as each was viewed as doing their part by the other, a positive relationship could evolve. Good rapport would be a part of this relationship, which took place in a comfort zone. This comfort zone was maintained as long as Donald did not put pressure on students that they viewed as unrealistic (such as requiring them to understand complex problems), and Donald was convinced that students were trying to "process".

The other relationship that was an important part of Donald's teaching practice was that which occurred among students. Students were to treat each other with respect and act responsibly, which many times meant taking into account the affect one's actions had on others. This was of particular importance at Einstein High School since the student population was diverse. Figure 4 can be used to represent this relationship.



Relationship
- Based on respect
- Peer pressure as a motivator

Figure 4.

The relationship among students in Donald's classroom was based on mutual respect and motivated by peer pressure.

Besides respect, the other interesting aspect of this relationship was the use of peer pressure as a motivator. Donald used peer pressure in both his physics classes (e.g., posting grades on a website so students could compare their scores with others) and his earth science classes (e.g., peer reading). "Instead of having students sit there and read by themselves. There is very little tension or very little effort for them to be able to sit there and read by themselves. But if they have to actually read to somebody else, they may actually have to try to struggle to read and pronounce words correctly. They may actually have to struggle and read it so it's clear and coherent enough. All of a sudden you see other students and you will be able to gauge your placement with other students. You might be behind. You might be ahead. In that sense there, they get automatic feedback. I think that automatic feedback is so beneficial" (Interview with Donald, 3/7/2001). Thus, other students were seen as the source of any pressure a student might feel to do better. Pressure of any form coming from Donald might damage the good rapport he held so dear and had worked so hard to cultivate. It might also disrupt the comfort zone where the relationship between Donald and his students existed.

Peer pressure has long been used by teachers to not only motivate students, but also for classroom management. However, not just any peer influence will do. The closer the relationship between students, the greater the impact any influence will have. Urberg (1992) found that good friends, rather than the social crowd, appeared to be the major influence on student behavior. Thus, it was not enough for Donald to foster working relationships among the students as a whole, but he also wanted to facilitate the development of friendships that would influence students in a positive direction.

Physics was Donald's teaching passion. He spent a good amount of effort on his physics teaching. He hoped that one day there would be enough students enrolled in introductory and AP Physics that he would not have to teach another science class. To help him meet this goal, Donald took his current physics students into the hall or into another public area to conduct some of the class' activities. "It gets my class out into the open. I actually go sometimes in the stairwell doing labs or something like that or we actually go to different locations in the school. This is my way of saying look 'This is more than just this room'. It involves in terms of exposing other students. They think 'Wow, what's going on?' So as a result just a few of those students see that and think 'Oh, maybe I ought to get into this class. What is this class about?' So that is another reason too, just for advertising and also to get them excited about science and physics" (Interview with Donald, 2/8/2001).

Donald was also aware that not only do students need to show enough interest in the course to enroll, but once a member of the course, they must be retained. The course must not be perceived as too difficult or the better students would not sign up. "In the physics class or in this case the AP for these two years, a lot of students are valedictorian candidates. That's a big issue for me, making sure their grade points are not hurt by that [decision to enroll in this course]" (Conversation with Donald, 3/29/2001). One interpretation of Donald's concern is that if it comes out that he grades hard, then students might be less likely to take his physics courses. Student enrollment might go down, and he would have more sections of earth science to teach, which is a less prestigious course and one that is of less interest to Donald. This view influenced his teaching in not only how hard he graded, but in what he expected of student performance.

Assessment. Assessments can have many purposes. Among other things, they can be used to determine students' initial understandings and abilities, to monitor student progress, and to collect information to grade student achievement (National Research Council, 1996). It seemed as though Donald had two purposes for his assessments. One was to award points to students so that grades could be determined at the end of a marking period. Donald provided ample opportunities for students to earn extra credit points to improve their grade. Another purpose was to give students the opportunity to display their effort in processing information. Not all students would develop a deep understanding of the key ideas and concepts. Some were limited in their command of the English language, and the resources needed to develop deep understandings did not seem to be present. However, displaying effort was something that each student could do.

For example, during one earth science lesson Donald had students attempt a set of questions drawing only upon their prior knowledge to answer them. Once they had responded, they were to draw a line across their paper. Below the line the students were to use their textbook to write the correct responses. I asked him what he would give points to when he graded this assignment. "Pretty much participation. Are they doing it? Are they writing it down? Are they making an effort? If they just basically give me the questions and nothing above and below. There's hardly anything to grade there. But if there's something below it [the line], that means at least they made an effort to look it up. They made an effort to be able to see, even if there's nothing above there, at least it shows that they tried" (5/18/2001). Thus, making a connection between the situation in the problem with prior knowledge by showing work above the line took on less importance than showing effort by looking up the correct answers in the text.

Reflection. During one of my conversations with Donald after school, I suggested that he give his earth science students a more challenging problem. My thinking was that if the activity required them to reason and apply some prior knowledge, then the students might not be as bored or unmotivated. The topic was contour maps, and I suggested that he start with giving the students a contour map with little direction and a set of questions to answer. My idea was to let them see what they could figure out while working with a partner, then provide some direction and give the students the activity once again. His response to this suggestion was: "What I'm trying to do is I'm trying to ramp them up to an activity that is more challenging. If you put the more challenging activity at the beginning such as reading the actual map and looking for the symbols and so on, some of them will get frustrated to the point where 'I don't understand' and it becomes a behavior problem. Then I'm going to be basically dealing with their behavioral problem because they don't understand. It's not all of them, but a lot of them will not understand how to behave in a manner. I'm basically dealing with adolescents to be able to appropriately show that you're frustrated or you need some help or I don't understand. Quite frankly, I don't know if I would want to put myself through that" (4/20/2001).

Donald saw a lack of maturity and a lack of coping skills with the ninth graders in earth science acting as a barrier to doing challenging activities with them. Thus, there was a tension in Donald's teaching. If he lectured or read to them, he ran the risk of students zoning out and not being engaged with the subject matter. But if he had them work on hands-on or more challenging projects, then behavior issues had the tendency to surface. Since he didn't want to deal with behavior problems (he wanted to maintain good rapport with students), he chose structured and more controlled activities.

Key Aspects of the Personal Factors That Will Be Reflected in the Occasions for Learning

The aspects that were discussed at the end of the section on context also appeared in this discussion of Donald's personal factors.

Mutual respect and "getting along". Donald worked hard to establish good rapport with his students, which he claimed is priceless. Students showed proper respect for Donald and each other. He developed a comfort zone for students to learn in by providing a structure, but not placing demands on them (other than to try). Peer pressure was used to motivate students, not rewards or threats from Donald. Finding ways of creating student interest in the topic to be covered also helped students get along with Donald and with each other.

Using the textbook and self. The textbook was the primary resource used by Donald when planning a lesson. He used worksheets, questions at the end of a section, and readings from the book for many of the activities in his earth science classes. In physics, many of the demonstrations and lab activities were directly related to textbook resources. He planned and taught alone since there were not any other physics teachers in the building, and no one had a solid background in earth science. He believed that teachers made sense of information on their own, like a novice teacher understanding the feedback notes he gave to him or her.

Learning about what works through individual active processing. Individual students needed to process information using the available resources. Processing takes time, so a comfort zone is needed so that an individual is likely to remain "processing". "Soak time" or "marinate time" is a big part of processing. Even though peer reading

requires working with a partner, individual students needed to make sense of what they were reading and struggle to make their reading clear and coherent.

Engaging in assigned responsibilities. The responsibility of the students was to exhibit good behavior in the classroom. According to Donald, by showing up for class students were making the statement that they wanted to learn or were at least willing to try. They were to show effort at processing information from available resources. Donald's responsibilities included the procedural tasks of teaching, meaning tasks would be unambiguous, activities would be well organized and realistic, students would be treated fairly, etc. Donald made resources available to the students and gave them opportunities to "process".

Continuing search for new resources. Donald's goal for his students was to make them self-directed learners. This meant they must be able to process information on their own. Donald described processing by using the metaphor of "soak time" or "marinate time". Students were to soak or marinate in the information contained in relevant resources, and he saw a big part of his job as making acceptable resources available to them. The more resources the students had, the more information they had, the more there was to soak or marinate in, and a more complete job of processing could occur.

A Focus on the Local Learning Community and Activities: Two Occasions for Learning

The Identification of "What" Is to Be Learned

Donald's teaching practice centered around developing a good relationship between a student and himself and fostering respectful relationships among his students, and it centered on helping his students utilize self-directed learning (SDL) through "processing". Merriam and Caffarella (1991) describe some of the key decision making

points about choosing what, where, and how to learn in self-directed learning as (a) deciding what detailed knowledge and skill to learn; (b) deciding the specific activities, methods, resources, or equipment for learning; (c) determining the pace at which to proceed during a learning episode; (d) estimating the current level of one's knowledge and skill or one's progress in gaining the desired knowledge and skill; (e) detecting any factor that has been hindering learning or discovering inefficient aspects of the current procedures; and (f) taking steps to increase the motivation for certain learning episodes. Thus, three bodies of knowledge and practice become important:

- knowledge of students and how to develop a good rapport with and among them,
- subject matter content that is included in the textbook, and
- knowledge and practices of helping students process information from resources.

Figure 5 is a representation of this intersection.

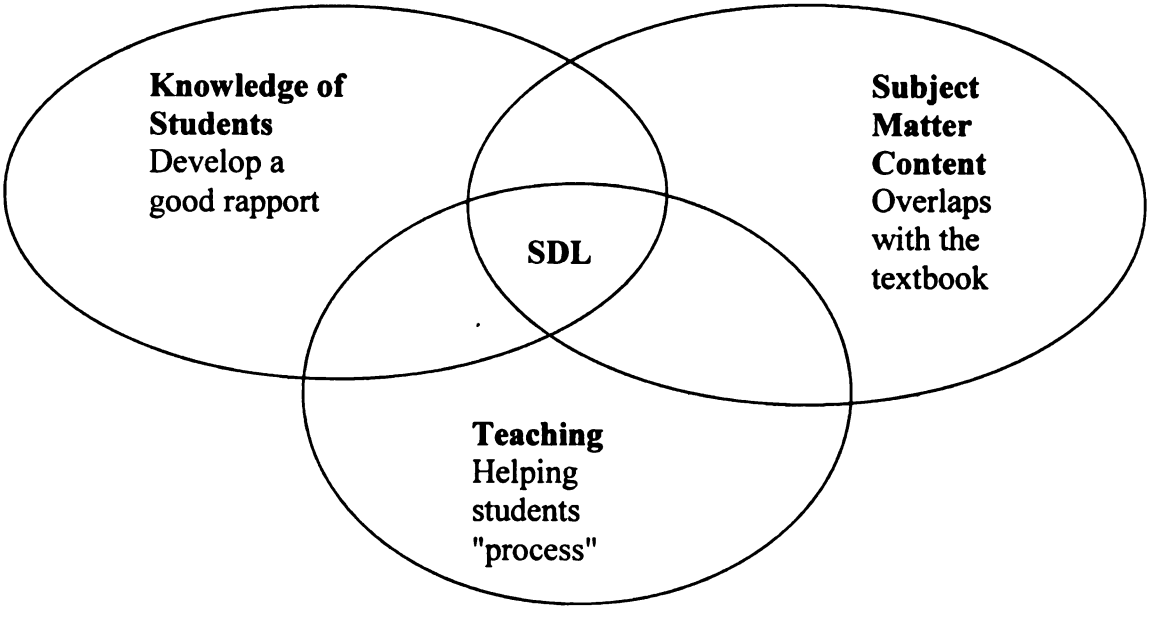


Figure 5.

Self-directed learning (SDL) can exist at the intersection of knowledge and practices related to students, teaching, and subject matter content.

This approach to teaching required Donald to develop good relationships with and among his students. He believed that if they liked him and respected him, then they would be more likely to go along with his teaching practices. Given that his classes were diverse, he needed ways of working with a variety of students. He also needed to understand how the backgrounds of students would interact. For example, during the semester that data were collected, a student from Serbia transferred into a class that had a student from Bosnia as a member. At the time, Bosnia and Serbia were at war with one another, and Donald was afraid that the tensions between the countries might surface as tensions between these two students. He needed to find ways of helping these students work together, or at least tolerate each other's presence in the classroom.

Donald felt he could learn from his intern since Doug was perceived as having a wealth of imagination and ideas. He wanted to see how an intern interacted with students. This could give him ideas, some of them might be ways that he didn't want to act and some other ways would be promising. Thus, Donald was always on the lookout for ways of improving relationships with all of his students. In addition, since he saw the need to motivate students, particularly his earth science students, he purposefully looked for ways to motivate without running the risk of damaging their relationship. Alternative ways of motivating students were constantly being sought by Donald.

The subject matter content that Donald and the students needed to know came from the textbook. By restricting the content of the course in this manner, Donald was making the statement to the students that they did not have to know everything about physics or earth science. In fact, they would only be studying a small part of the content (that which was represented in the textbook) that was well established and unambiguous.

This core of knowledge was the focus of many of the activities that were undertaken in the lessons, and only this material would be the root of many of the questions students asked. This approach to teaching necessitated that Donald be able to clearly present this material to the students and be able to adequately address student queries.

One of Donald's responsibilities that came from this approach to teaching was to make resources available to his students so that they could process information. Since students would be spending a good amount of "soak time" processing these resources, not just anything would do. These resources needed to be acceptable, meaning that they represented a limited amount of well-established knowledge and were unambiguous. This led to the first occasion for learning where Donald had his AP Physics students create websites based on important topics from the textbook that would be on the AP exam. If properly constructed, these websites would clearly display relevant information and could be used as a resource for students to process information related to these topics. They could help students become self-directed learners.

In the second occasion for learning, Doug questioned his own teaching practices and his progress toward teaching for understanding. This was a quite different goal for teaching than Donald's explicit goal of making self-directed learners. Donald's response was one of helping Doug become a self-directed teacher, which was the type of science teacher at Einstein High School. The important aspects that came from the context and Donald's personal factors are used in these occasions for learning for analysis.

Occasion One: Using Time Freed Up by the Intern's Teaching: Creating an Alternative Teaching Strategy for AP Physics

The internship required Doug to teach for an extended period three different times during the academic year. Two two-week guided lead teaching periods occurred in the fall semester while the main lead teaching period extended for ten weeks during the spring term. During these times, the intern was primarily responsible for all of the planning, teaching, and assessment of the classes. While the mentor teacher was there to assist the intern with issues and questions, her or his role had more of a coaching element to it than as a lead teacher. According to Tomlinson (1995), coaching involves diagnosis, assistance, encouragement, and collaborative support. Through monitoring the actions of the intern, the mentor diagnoses and promotes understanding of teaching issues, awareness of strategies, and help with planning, preparation, and reflection.

Since much of the workload fell to the intern during these times, the mentor teacher could find him or herself with some freed up time. Donald decided to use some of his time to create a teaching strategy that he hoped would help make his AP Physics students self-directed learners.

Mutual respect and "getting along". Donald wanted to employ some of the methods he observed one of his novice teacher mentees (Mark) use in his computer science classes. Fortunately, Mark's prep period coincided with Donald's AP Physics course, so the computer room was available for use, and Mark was around to assist with any problems that arose with the technology. According to Mark, he showed Donald how he taught his computer class, along with using html and an on-line quiz website. Since

Donald was not asking Mark to do anything that he was not already very familiar with, Mark agreed to help.

According to Donald, students were more engaged working on a computer. They learned well, so he claimed according to research. Their interest level was maintained since they were not bounded, like they were by a packet of papers. Therefore, the likelihood was probable that students would get along during class. Some research has indicated that Donald is correct in his perceptions. For example, Kinzie (1990) examined the interdependence of learner control, self-regulation, and the continuing motivation to learn as being beneficial of effective, interactive computer instruction. Beichner (1994) found that, although the technology had an important role in student activity, the task itself was the main motivational aspect for students engaged in computer assisted instruction.

Continuing search for new resources. Donald's new strategy was to have the AP Physics students work with a partner to create a website based on one of the topics in the course. The elements to be included on the website were misconceptions, problem sets, notes, formulas, practice problems, and a quiz. These elements were determined by looking at the old AP Physics exams. Once all of the pairs had completed the construction of their website, each group would explain their topic to the class using the website as a resource in their presentation. As Donald noted, "It was my way of being able to get them to develop a learning system other than just written paper and pencil, and it was also my way of saying we can use technology. We have the means. And also to give them a variety of learning experiences" (Debriefing with Donald after a lesson, 3/5/2001).

Donald understood that students became easily bored with taking notes and listening to a teacher. He wanted to use a means (technology) that many students were already comfortable with and find interesting. Most of these students had already created a website, either on their own or as a part of a class. Thus, he was respecting the interest of his students by employing this approach in his class. In addition, Donald claimed, "It also seems inevitable that we will teach differently based on advances in technology. We are doing the students a favor in teaching them with the latest technology. Students are more excited about this. The dynamics among students and between students and teacher is different" (Debriefing with Donald after a lesson, 3/7/2001).

Indeed research has shown that the use of computers and other technology does change interpersonal dynamics in the classroom. Svensson (2000) found that students interacted more when they were using the computer. Most of this interaction was concerned with problem solving, and students indicated they focused intently on the task because they had limited time for computer work. In addition, Susman's (1998) work provided more evidence that cooperative learning and problem solving utilizing computer-based instruction are important factors in increasing achievement, group interaction, and collaboration in cooperative computer-based instruction.

Using the textbook and self. The topics for the websites came from the textbook. There were nine student pairs, and each was assigned a different chapter. Thus, it was of little surprise that in creating the websites, most students used their current physics text as their primary resource. Other physics textbooks from the 1980's and 1990's were also used. As I observed the students design their webpages, many just typed the information

from the text into the computer. They then added some graphics and other items that made the presentation of the material quite slick.

Most of the student pairs had assigned different pieces of the website to each individual. In other words, one student would work on the presentation of a problem set while the other student worked on displaying "content" on the screen. There was little discussion between the students during this time. Only on rare occasions did I observe one student ask the other what something meant or how the different pieces of the website were going to come together conceptually. Much of the interaction between student pairs was limited to the technical questions concerning the construction of a website.

I had the opportunity to sit down with Donald and discuss the website on electrostatics. Donald gave me his impressions of the students' work and his evaluation of their level of understanding. "The level of understanding I saw right here. This was nice. They got a formula at least using subscripts, superscripts, and so on. That shows to me that at least they knew that they could be able to get the formula, and they knew that this was the right kind and best format for the formula." [But they copied this directly from the textbook.] "They didn't tell me what 'k' was." "What is Q1 and what is Q2? They should explain these variables."

Some of what was written didn't make sense to him, which is typical if text is copied without much concern over making it understandable to a reader. "When you're using different variables, that tells me that they're not thinking about in terms of how to be able to understand what that variable means. If it was the same, you would use the same letter." "What do they mean by the electrical charges being 'conserved'?" "I would

have had in parentheses meaning it can't be created or destroyed, and it can be only transformed...So I would have had something in parentheses saying what that meant. That would be my ideal" (Notes from evaluation session, 3/29/2001).

Learning about what works through individual active processing. Donald was not satisfied with how he taught AP Physics the previous year. He felt he lectured too much, and the students only needed to memorize facts and procedures and regurgitate them on a test. By having them create something new (the website), Donald was hoping that students would locate multiple resources, process the information in these varied books and other sources, and be able to display their understanding on the computer. He was providing time in the computer lab where students could "soak" or "marinate" in the resources available to them.

I believe Donald was convinced that developing a website was a good exercise for the students to go through to help them process the information on their particular topic. It is interesting to note that in order to produce a website where the creators can display an understanding of some depth of their topic, they would need to *analyze* information from multiple sources and *synthesize* their findings into a coherent presentation of their topic. Analysis and synthesis were the two components of Bloom's Taxonomy that Donald did not mention in his definition of processing, which was presented earlier.

Engaging in assigned responsibilities. So how did the students fare during their presentations? I observed one group make a presentation on electrostatics over a two-day period. The students struggled. Their presentation lacked some coherence and a sense of a command of the subject matter. At one point, a student asked about the last three questions on their website. The presenters didn't know how to address these questions.

They had to look up information in the book. Even then, they read some definitions. It was evident that they didn't understand how to do the problems, what formulas to use, and the concepts underlying the problems. Donald made some suggestions for future presentations:

- Presenters should meet with him to obtain the solutions manual and talk with him before they presented.
- He would bring in an overhead so that students could draw diagrams and do the problems.
- One presenter was to bring in a calculator to solve the problems. (Classroom observation notes, 3/19/2001)

Donald's response to the students' poor understanding of the subject matter was to provide them with more resources. Information from these resources, particularly the solutions manual, was to be processed by the students in order to improve their presentation. However, even this suggestion provides limited help with developing an understanding of the content that the students would have to teach. While the solutions manual could provide models of proper solutions and Donald might fill in conceptual gaps during a pre-presentation discussion, another interpretation would be that the solution manual and Donald's pre-presentation comments would act as other resources that may or may not be internalized by the presenters. They may just play a role in the procedural techniques used in the presentation.

It is interesting that suggestions 2 and 3 from above provided assistance with the procedural aspects of making an effective presentation. In addition, some of his comments when reflecting upon the website were related to procedural aspects. He liked

the graphics and animation on the site, and the fact that it was clean and orderly. He noted that they need a 'home' button (to make things easier for the learner). He wanted to see formulas and definitions from their text or another text (providing a useful resource). All of these suggestions were related to the "procedural tasks" responsibilities Donald saw a teacher having. He was helping these students carry out this responsibility.

During the second day of their presentation, things didn't get much better. As the presenters went through questions from the problem set about twenty-five minutes into the class, one student said, "McMaster, why don't you teach us? It's obvious Billy [the main presenter] doesn't know what he's doing. Are you boycotting teaching or something?" The students seemed restless since they didn't understand the logic of the presentation, and Billy was not a forceful presence in the classroom. He used a low voice. He was sitting on a chair at the overhead, not standing. He was copying work from the solutions manual. It seemed few of the students had attempted the problems beforehand since most of them were copying the solutions to these problems from the overhead (Classroom observation notes, 3/21/2001).

Here there was a breakdown in the assigned responsibilities of the teacher and the students. Making a clear and orderly presentation to the class that makes sense was seen by the students as one of Donald's responsibilities. He was not doing this, so the students became easily frustrated with the "replacement teacher's" lack of clarity and cohesion. Billy was not acting like a teacher should: His voice was low; he was sitting during the presentation: he was just copying work from the solutions manual with no interpretation; etc. The students' main responsibility was to attempt the problems ahead of time, which

many did not do. Thus, they were not showing effort. The relationship that was built upon each individual fulfilling his or her assigned responsibilities was in jeopardy.

Donald's Learning Outcomes - Occasion One: Using Time Freed Up by the Intern's Teaching: Creating an Alternative Teaching Strategy in AP Physics

Learning outcome. Due to time constraints and the students' less than enthusiastic reception to many of the presentations, Donald decided to change his approach. The students were also concerned about understanding the content from the student presentations. Donald decided that only two days per week would be spent in the computer lab doing student presentations. The remaining time would be spent in the physics classroom doing lectures, demos, or labs. "I sense that what was happening is that because they were just given one mode [the presentations based on a website], even if it was this mode, that it still wasn't clicking on all cylinders for some students. As a result, we're going to go ahead and try [another] approach." There was disappointment in Donald's voice since he had hoped that student presentations would be a very effective means for student learning. However, he now realized that a complete reliance on the presentations would not do; he needed to mix in his own presentations. He determined this through his own observations and from going to an AP conference. "They said you have to get through this material at this rate. At the rate we were going we would not get through it" (Conversation with Donald, 3/29/2001). Thus, part of the reason for this change was also due to Donald's desire to cover all the content before the AP Physics exam in May.

Donald attempted a new teaching strategy with this class. He wanted to develop a system where students would teach each other while using technology. He felt that if

students were to know something so well that they could teach it to others, then this would help them "process" the information. "So I'm torn with this idea that we could go back to the format of here's what I want you to know. I'll quiz you over it. You regurgitate it. I don't really want to do that. I want to be able to try something where I know it may increase their understanding. I want to also give them something so that they have more ownership to it. That was the whole impetus of doing this" (Notes from a conversation with Donald, 3/21/2001).

Donald achieved this goal to a certain extent. Undoubtedly, the students did process some of the concepts and theories while creating their websites and preparing their presentations. However, their presentations did not display a great degree of understanding. Donald decided to change his teaching strategy from being exclusively student presentations to one where the presentations would play a role, but so would some instruction from him. Thus, Donald learned that the creation of websites could be a potentially useful activity in covering the content, however modifications to his current strategy were needed. This is a legitimate outcome since rarely in teaching does something work as hoped on the first attempt, particularly when it is as complex as creating an entirely new teaching strategy.

The influence of Donald's personal factors. An influential part of Donald's philosophy was to help his students (and his intern) become self-directed. He wanted to create situations with his students that would give them opportunities to act on their own. Donald was resisting the temptation to teach them directly. "I know that if I can get them to see that if they can develop something of their own, then when they get out on their own in terms of school, and if they can be able to digest and process that information,

college will be a cake-walk for them. Essentially that's the same you do when you go to college" (Conversation with Donald, 3/21/2001).

Given this goal for his students, it was of little surprise that Donald spent some of the time freed up by Doug teaching the earth science classes to develop a teaching strategy that required students to be self-directed. Students needed to take the resources provided to them, internalize the information, and create something that represented their understanding. This goal also shows Donald's concern for preparing students for their future.

The influence of the norms of the science department. The members of this science department by and large worked independently. There was not a lot of sharing of ideas or resources that occurred among them. Donald was the only physics teacher at Einstein High School, so no one else was readily available to engage in reflective dialogue concerning the teaching of this subject matter. He did rely on Mark, the computer science teacher, but only for technical assistance and for ideas about the procedures students should use in creating a website. All of this added to the success of this first attempt at changing his teaching practice being less than he had hoped.

Occasion Two: Teaching Earth Science for Understanding

In the previous chapter, we saw how important aspects of personal factors and the context of the school and science department could become a learning strategy and be used to explain the activities in which a mentor teacher engages to enhance her own teaching practices. The use of the learning strategy was equally helpful for both a complex occasion for learning and a less complicated one. Was the use of a learning strategy exclusive to Betty?

No, the previous occasion for learning in this chapter showed that the use of a learning strategy was useful in explaining an occasion for learning for another teacher. The next question that needs to be addressed is: Can the learning strategy be used to help explain an occasion for learning that is not taken advantage of by the mentor teacher? If it can be shown that the learning strategy is useful under these circumstances, then the conceptual framework from this study will be even more powerful. Let us investigate an occasion for learning associated with the teaching of convection to earth science students.

Mutual respect and "getting along". It came as no surprise that Donald wanted to establish good rapport with Doug, as well as his students. Donald wanted to provide a structure for Doug, but did not want to be seen as overbearing. "I try not to influence overwhelmingly and say 'Doug, I think you ought to do this period, or do this.' I feel that if we disagree, we disagree. That's just the difference in teaching style, and I don't take it personally. I look at it that this is your point of view. This is your technique. I want to make sure that's valued" (Debriefing with Donald about Doug's lesson, 3/15/2001). Mentoring is, by definition, a relationship, one that the mentor needs to take an active role in fostering and developing. A mentor must consistently recognize trustworthiness and professional growth as the defining dimensions of the mentor/novice relationship, and the mentor must accept the ongoing responsibility of building and maintaining a professional relationship with the novice (Odell & Huling, 2000).

By not questioning Doug's techniques too closely, Donald felt they had a good chance at getting along. He saw giving correction and feedback as being the greatest challenge to working with an intern. As Donald put it, "Other mentors in the past weren't able to give their mentees time, or they just pissed them off. As a result they left, and I

didn't want that to happen" (Conversation with Donald, 3/16/2001). Thus, Donald made himself available to Doug on a regular basis, and he was always willing to give Doug ideas for activities when he asked. In return, Doug was doing the bulk of the work in teaching the earth sciences classes, which freed Donald to work on other things.

Engaging in assigned responsibilities. Doug was an earth science major who spilt his time during this internship between Donald's earth science classes and two geography classes taught by another teacher down the hall. Doug saw his main responsibility in earth science as being to learn how to teach for understanding, since that was the goal of the university's science teacher education program, and it was his personal goal as well. He claimed that he learned science by studying a book and memorizing information, but he did not want to teach in this manner. He wanted his students to "see" it, meaning that he wanted them to develop understandings and an appreciation for science theories and concepts. He credited the university's teacher education courses for helping him come to this perspective.

During the first part of March, Doug's frustration level was up. He didn't feel that his students were understanding much, and he wanted ideas for how to make the curriculum "come alive" for the students. He felt he was lecturing too much and needed to do something other than focus on vocabulary terms and simple concepts. A piece of a meeting between Doug and Donald follows.

Donald asked what the next topic was for Doug. He also asked how he would teach a few of the main concepts. Doug was looking for representations to teach convection. "A lot of them even said that today. They are still a little confused over

convection. So what do I do? How do I teach this so that they are not just memorizing it? That is basically what I did [as a student]. I just heard it so much that I just know it."

By posing these questions, Doug was acting on his assigned responsibility to learn how to teach for understanding. He had witnessed a lack of understanding on the part of his students, but he did not know how to proceed. He asked Donald, since he was familiar with the students in this school and had taught the subject matter in the past. However, instead of receiving a response that Doug would deem helpful and directly connected to his query, Donald suggested creating a physical model of convection. This suggestion was based on Donald's assigned responsibility of making resources (physical models) available to students so they could process the information contained in the model.

> Donald: "You know what comes to mind really quickly, but I don't know as to what the practicality of it is. Look at belts and having different colored belts representing different layers, or if you had any marshmallows. The other thing is that..."
>
> Doug: "Where am I going to get movement?"
>
> Donald: "Yeah, exactly. Then you would need to find something where it would be something that would actually move."
>
> Doug: "Right."
>
> Donald: "What you are trying to do is create a physical model of it."
>
> Doug: "Right." Doug explains a couple of models he has used, but he doesn't feel comfortable that the students would be able to carry on a discussion about the topic. "How do I teach this so that they are not just memorizing this?"

When Doug continued to question how he could teach convection for understanding (an occurrence that was rare in this science department), Donald responded with an activity that Doug could try. This activity was based on another activity Donald had his physics students complete. Creating and making available activities to students was another procedural task of teaching (one of Donald's assigned responsibilities).

Donald responded with the idea that these students should be able to design a lesson that a third grader could understand.

Doug: "Okay, so how are they [the ninth graders] going to learn it?"

Donald continued with the procedures Doug could use by suggesting that he utilize the nearby elementary school for an audience.

Doug: "Yeah, I know what you're saying though. But I'm saying if I want them to teach a lesson that I never really taught them my way, how are they going to be able to go about learning it themselves? Am I going to feel comfortable enough with them teaching somebody else? I mean, how are they going to learn it? Are they going to go read? Watch a movie? Does that really work, or are they just memorizing it?"

Donald ignored these questions and continued to explain what he did with his physics class when they went to a local middle school to teach a topic and how this could be related to what Doug could do with his students. Donald's students gave a pre-assessment. Then they came up with posters and skits, and finally they gave a post-test.

An interesting piece of this dialogue exchange was when Donald did not respond to the string of questions posed by Doug concerning how the students were to learn about

convection so that they could teach it to elementary students. The interpretation suggested here is that Donald does not pay attention to these questions because they are unrelated to any of his assigned responsibilities. Providing students with activities in which to engage is a procedural task of teaching, and therefore Donald chooses to focus his response to Doug by continuing to elaborate on an activity that Doug could enact. Doug continues to question Donald because it is unclear to him how Donald's response is relevant to Doug's assigned responsibility, teaching convection for understanding.

Learning about what works through individual active processing. This dialogue exchange continued. Up to this point, Donald may have been interpreting Doug's query of "What do I do?" as meaning that he needed ideas for activities to enact, an assigned responsibility for a science teacher at Einstein High School. However, when it was clear to Donald that Doug was not picking up his suggestions for either developing a physical model of convection or using the activity where Doug's students would teach a lesson to elementary students, he reinterpreted Doug's question. He now viewed the question "What do I do?" as meaning that Doug had not sufficiently processed all of the information he had from the available resources (the students' lack of understanding, the activities that Donald just offered, the text in the book concerning convection, etc.).

> Donald: "So over the weekend, I'm going to go back again and mention to you that come up with ways in which you think you can apply it."
>
> Doug: "I'm trying to."
>
> Donald: "Hey, you know, it may take wracking your brain a few more times. Sometimes you have this what is referred to as soak time or marinate time. Whatever you need to do to get you to visualize something in a different way. But

I think that's the angle that, you're exactly right because you're at the same point where you were with the rock cycle. Part of teaching is making sure that you feel comfortable with it." Donald tells Doug that he did not want to put pressure on him. "If you don't think something went well, go back. Figure it out, okay."

By suggesting Doug wrack his brain over the weekend and the belief that some "soak time" or "marinate time" was needed, Donald was suggesting that Doug needed to process. Doug was in a similar situation when he was teaching the rock cycle, and he successfully "wracked his brain" until he came up with a way to teach this topic and students developed a decent degree of understanding. This gave Donald some confidence that his suggestion would work this time. Doug needed to find a way of teaching that made him feel comfortable (a norm in this science department), and Donald didn't want to put pressure on him (a key feature of not damaging good rapport).

However, Doug did not feel that "wracking his brain" was helpful advice. After all he was accustomed to working with the other interns. Collaboration and sharing of ideas was the norm in this group, as was a focus on student learning. The interns wrestled with questions of how to teach for understanding. Doug, using the norms of this group and engaging in his assigned responsibility of learning to teach for understanding, posed some of these questions to Donald:

Doug: "I'm lost. Where do I go? How do I make them understand? What am I looking for to get them to understand it better? If I want higher achievement, what do I do? Am I going over too much material? Am I asking questions that are too difficult? Is the discussion not good? What's not good in my teaching? Am I not planned enough? Do I not plan well enough? Do I need to plan better? I anticipate

they are going to understand everything that I do and I try to reinforce it. But this whole idea of teaching for understanding. You can tell me, but it doesn't mean I necessarily understand how to do it."

Donald: "I tell you what. There's a lot of teachers including myself who are wracking our brains trying to figure that out too." Donald then told Doug about something he read in one of his master's level classes. Donald sounded like a textbook. He did not pay attention to the specifics of Doug's situation.

Donald's response was expected. Learning about what to do in your classroom was an individual activity in this science department. Only by wracking your own brain would you come up with a solution. Once again, this included processing information, like that found in the textbook of a master's level course. Also, as expected, Doug was not satisfied with this response.

Doug claimed he was doing what Donald said the book stated. He wanted to know why his seventh hour class didn't "get it" when his fifth hour class did. He didn't think the labs were working.

Donald: "If certain things are not working, you've got to think differently then [i.e., find your own way of teaching]."

Doug: "In what way?"

Donald brought up the idea that Doug needed to think of teaching as being age appropriate. He said once again that Doug needed to wrack his brain over the weekend. He said that Doug could fall flat on his face and that was okay. He did this. [This admission helped to maintain the rapport that they had developed. (i.e.,

Donald did not have an answer that he was hiding from Doug. They were both struggling with the same issues. They were equals in this regard.)]

I observed their meeting the following Monday. Even though Doug was supposed to "wrack his brain" over the weekend, the topic of conversation during Friday's session never arose during this meeting (Notes from meeting, 3/5/2001). If Donald had asked about what Doug had determined from wracking his brain, he ran the risk of having Doug admit that he hadn't determined anything. This admission on Doug's part could put pressure on him and damage their good rapport.

Using the textbook and self. Another characteristic that helps explain what occurred in this occasion for learning is the limited subject matter knowledge Donald possessed outside of that represented in the earth science textbook. Donald had taught this subject for only a couple of years. By his own admission, he had taught the course pretty much straight from the text. He did not have the depth of subject matter knowledge in earth science like he did in physics. Thus, he was limited in ideas for implementing effective and meaningful projects, demonstrations, and activities in earth science, since these fell outside the realm of his current teaching practices.

The importance of subject matter knowledge is addressed in the Standards documents. For example, the *National Science Education Standards* (NRC, 1996) states that all teachers of science must have a strong, broad base of scientific knowledge that is extensive in breadth and depth. Breadth implies a focus on the basic ideas of science and is central to teaching science at all grade levels. Depth refers to knowing and understanding not only the basic ideas within a scientific discipline, but also some of the supporting experimental and theoretical background. The ways ideas interconnect and

build upon each other within and across content areas are other important features of depth of understanding. In this case, both Donald and Doug were lacking a depth of understanding of convection that hindered the development of an effective pedagogical approach to teach for understanding.

Donald had the belief that it was important for Doug to rely on himself and to develop his own teaching style and approaches. This was seen by Donald as a "higher level of learning of being able to go and branch off from what you know." If Doug mimicked Donald, this would mean that "he is not really growing that much or he's not having that much of a struggle in trying to develop his own personality and his own teaching techniques. That's really ultimately comes down to it is that through the years you develop your own teaching style. Your own teaching style works for you. It may or may not work for somebody else. You can take bits and parts of someone else's repertoire" (Debriefing with Donald about Doug's lesson, 3/15/2001).

This belief is consistent with the science department's individual approach to teaching. Each teacher taught in a manner with which she or he was comfortable. Donald believed Doug must find this approach for himself. It was not something that Donald could impart on him. If the two of them put their heads together and came up with ideas for how to teach convection for understanding, then Donald was not fulfilling one of the purposes he saw as crucial in his role of being a mentor, namely to teach the intern to be self-directed. In addition, since the norm of the science department was to figure teaching problems out independently, then Donald was propagating this common practice with Doug.

Continuing search for new resources. Both Donald and Doug were seeking new resources to assist with their teaching. However, Doug was looking for resources to help him teach for understanding. This purpose was quite different from the purposes Donald had for his teaching. Donald's earth science course was a rich mixture of students from different ethnic backgrounds. Some students did not have a very good command of the English language. Having students learn to respect each other and to respect their teacher was of high priority to Donald. Developing a deep understanding of convection that could be expressed either verbally or in a written format was unrealistic in some cases (for those students who did not speak, read, or write the English language). In other cases, it was a huge challenge (e.g., for students who were repeatedly disruptive and/or unmotivated). Donald may very well have believed that helping Doug think of ways to teach convection for understanding and develop resources for this purpose was not practical under these circumstances or worth much time and effort. It made more sense to Donald to look for resources that were restricted to manageable amounts of unambiguous and well-established material, like those that came from a textbook. The nature of these resources was such that students might have a reasonable chance of processing them if they put in some effort.

Donald's Learning Outcomes - Occasion Two: Teaching Earth Science for Understanding

Learning outcome. The above incident could easily be seen as an occasion for learning. Doug raised an issue and a set of questions for which neither participant had a ready response. Neither of them had strategies for engaging the students in deep and meaningful ways to learn about convection. Thus, a need in each of their teaching

practices had been exposed. Resources were available in that they had textbooks, the Internet, time during the weekend, and other teaching supplies. In addition, they had each other to develop ideas. Yet Donald did not utilize this occasion to enhance his own teaching practice. However, it has been shown that the characteristics put forth in this analysis are helpful in understanding an occasion for learning that presented itself, but was not taken advantage of with respect to enhancing a mentor teacher's teaching practices.

The undersized number of learning outcomes for this occasion were undoubtedly influenced by Donald's lack of mentoring experience. Working with more interns in the future will allow for a greater range of experiences in helping a novice learn to teach, and it will also permit for reflective time to consider other options. Furthermore, this occasion for learning was based on a question (How can convection be taught for understanding?) that was not developed by Donald. As was discussed in the case of Betty, adult learners tend to be goal oriented, and ideally it is most effective for establishing productive learning outcomes if the learner develops the goal.

Within the science department, norms of collaboration, patterns of reflective dialogue, and deprivatizing one's practice were not frequently practiced, Thus, these norms, patterns, and practices were not readily available to Donald when working with Doug. If they were to collaborate, engage in meaningful reflective dialogue, and closely analyze each other's teaching practice, all of these would have had to be established "from scratch". This required more support than was available from the school, the science department, and the teacher education program.

From the second occasion for learning, Donald's learning outcome was limited at best. Even when he sent Doug off on the weekend to "wrack his brain" about developing activities that would assist students in developing a deeper understanding of convection, he did not follow-up with him at Monday morning's meeting. So if Doug had come up with a good activity, Donald was not privy to it.

Due to his lack of engagement with the teaching of earth science, at the end of the internship Donald was wondering how he should proceed. "I'd be very interested to see if I can use this same kind of energy towards the earth science [as I use in my physics teaching]. That right there would be my biggest challenge. I'm seeing this with Doug leaving. He's trying some interesting things. I'm trying to figure out 'How will I now take the mantle and go? How will I approach this now?'" (Conversation with Donald, 3/29/2001).

The influence of Donald's personal factors. The characteristics that are related to Donald's personal factors were used to help explain why Donald did not engage more fully with Doug's attempts to teach convection for understanding. Donald's belief that teachers need to find a way of teaching that is comfortable to them stood in his way of becoming more involved in this occasion for learning. Donald believed that Doug needed to process the information available to him so that he could come to his own understanding of how to proceed. He also did not see teaching convection for understanding relating to his assigned responsibilities of making activities available to students that are closely aligned with the textbook.

The influence of the norms of the science department. The science department did not put great emphasis on teaching earth science. It was the course that filled in the open

times in a teacher's schedule. From my observations as a field instructor at Einstein along with being there for dissertation data collection, I noted a sense that the teachers did not enjoy teaching this course, and they held rather low expectations for it. Donald was no exception. Given this atmosphere, one interpretation of Doug's questions about how to teach convection for student understanding was that he was being "rude" and demanding about an issue that science teachers didn't discuss with one another. If students could learn to "get along" and respect was shown, then some of the social goals of the school and the department were met. Thus, Donald was looking for ways to "work with" earth science students. Those who wanted to learn the concepts and the theories would if they processed the information in a self-directed manner.

Conclusions

A few things that seem relevant given the preceding discussion of the occasions for learning should be emphasized. It is evident that Donald put a great emphasis on respect, respect to be shown to students and their respect for him as the teacher and the respect that students should show to one another. This perspective influenced his teaching. He wanted to show students he valued them as individuals, and he understood that each of them was unique. He was interested in teaching strategies that allowed him to "work with" students effectively. This was consistent with the school's vision of helping students "get along" with others.

The Interrelatedness of the Planes

Based on the examination of the three planes from the conceptual framework, a summary table was constructed showing how each element of the strategy Donald used in the occasions for learning is related to aspects of each of the other two planes. It seems

that the strategy he used for mentor teacher learning is adapted from his personal factors (namely his philosophy of how learning takes place) which are related to the context that existed at Einstein High School.

Table 8

The Relationship Among the Context, Personal Factors, and Characteristics of Activities

Characteristic	Context	Personal factors	Activities
Mutual respect and getting along (Social environment)	Teachers showed respect of one another by not questioning teaching practices Showing respect was a goal for student interactions in the school	Developing good rapport with students Develop a comfort zone for students Students showed respect towards one another	Mark was helpful, but only with procedural items Donald created a comfort zone in his relationship with Doug by not putting pressure on him
Using the textbook and self (Resource use)	The school had scarce material resources, but textbooks were available The majority of teachers "do their own thing", meaning they taught in ways that made sense to them and did not rely on others	Donald taught directly from the textbook for earth science and used activities that were closely aligned with the text in physics There were no other physics teachers to plan or teach with and no one in the school had a solid background in earth science, so Donald was on his own	AP Physics students used information from the textbook to create their websites and they worked primarily by themselves doing this task How Doug wanted to teach required multiple resources and fell outside the realm of just using the textbook Donald wanted to impress on Doug that he needed to rely upon himself

Table 8 (cont'd)

Characteristic	Context	Personal factors	Activities
Learning about what works through individual active processing (Learning process)	Teachers taught in their own way, so there was little need for sharing and collaboration Feedback provided to novice teachers was used in their own way	Individual students needed to process information using available resources Time was needed for processing so this work should take place in a comfort zone	Donald developed his website teaching strategy on his own, with only a little procedural help from Mark Students needed to "process" information to create a website Doug needed to "wrack his brain" "Soak time" or "marinate time" was important
Engaging in assigned responsibilities (Defining tasks)	Students were to act in a responsible manner Students did activities and took assessments Teachers covered what was in the textbook Teachers did what it took to teach in their own way	If students showed up to class, they should be willing to try Students were to exhibit good behavior Students were to show effort at processing Teachers were responsible for the procedural tasks of teaching Teachers were to make resources available and give time to process	AP Physics students were upset that the presenters were not making a proper presentation Doug saw his responsibility as being to learn to teach for understanding Donald saw his responsibility as to provide Doug with "resources" and to help him become a self-directed learner

Table 8 (cont'd)

Characteristic	Context	Personal factors	Activities
Continuing search for new resources (Nature of a satisfactory conclusion)	Science teachers looked for new worksheets and demonstrations New resources needed to be aligned with pacing guides, textbooks, and being able to act on one's own	New resources were needed to provide more information for processing Resources should be based on a limited amount of well established, unambiguous information	It was hoped that the student generated websites would include information from multiple resources and become a new resource in subsequent years Doug was looking for new resources as was Donald, but since their purposes for teaching were different the types of resources that were valued were incongruent

Once again it is important to note that different data sources were used to establish the contents of each column. The examples in the "Context" column primarily came from interviews conducted with teachers in the science department and science interns. The examples in the "Personal Factors" column largely came from interviews with Donald, asking him clarifying questions after an activity, and observations of him teaching lessons. The examples in the "Activities" column came from observations made during interactions between Donald and Doug and during AP Physics lessons. Thus, strength is added to the claim that the aspects listed in the first column are the important ones to pay attention to concerning Donald's learning strategy when responding to an occasion for learning since they are common among a wide range of data sources.

Summary of the Chapter

This chapter presented the story of Donald's learning from the experience of being a mentor teacher. Discussion concerned not only what was learned, but also how learning took place by taking into account the context, Donald's personal factors, and the strategy he employed during two occasions for learning.

There was a tradition at Einstein High School of working independently, meaning that teachers taught in their own way and were not questioned about their teaching practices. Since everyone was doing their own thing, sharing of ideas and resources was not seen as important. Any changes in teaching practice usually occurred as the result of a teacher working on it by him or herself. This was the approach Donald used when attempting a new teaching strategy in his AP Physics course. The school's focus was on being responsible and showing respect. Subject matter knowledge in earth science and physics was limited.

Donald was a hard working, caring, and committed science teacher. His explicit goals of having students respect him and one another were very evident in his practice as was his desire to work with students in a positive manner. He wanted his students to learn to be socially responsible, and he wanted to assist his intern in becoming a well-started novice teacher. Donald had also identified some weaknesses in his teaching that needed attention. He viewed his work with Doug as being helpful in the enhancement of his teaching practices. However, he did not reap all of the benefits from an occasion for learning that was associated with being a mentor teacher as he might have.

The activities that were the focus of this chapter were two occasions for learning. The first was the development of a new teaching strategy to be used in AP Physics. This

was not a complete success. However, Donald did gain some insight into creating websites as an approach to teaching and learning. The second occasion for learning was not taken advantage of to its greatest extent. In each occasion for learning, Donald utilized the same strategy for learning, as stated below. This strategy is related to both Donald's personal factors and the context of Einstein High School and was useful in helping us make sense of what was happening.

- Mutual respect and getting along
- Using the textbook and self
- Engaging in assigned responsibilities
- Learning about what works through individual active processing
- Continuing search for new resources

Chapter 5: Conclusions and Implications

Overview of the Chapter

Key Conclusions

Conclusion one: Remarkably detailed parallels exist among key elements in the context in which a mentor teacher works, the mentor teacher's approaches to teaching and learning, and the mentor's response to occasions for learning during the internship.

Conclusion two: Differences in these key elements can account for differences in "what" was learned and "how" it was learned.

Social environment

Resource use

Defining tasks

Learning process

Nature of a satisfactory conclusion

Learning outcomes

Other occasions for learning were present during the internship

Students showing evidence of not understanding

Connections to Other Research on Mentor Teacher Learning

Implications

For teacher education programs

For educational research

For professional development

Limitations

How unique were Betty and Donald's experiences?

An incomplete study of the context

The timing of data collection

Questions for Future Research

How generalizable are the results of this study?

Among secondary science mentor teachers

Outside secondary science

Application to activities not associated with being a mentor teacher

Changes in patterns of practice

Final Comments

Overview

This chapter sums up the conclusions that can be made from this study. It also provides a discussion of the implications of this study for future work. Before ending with some final thoughts and comments, it describes some of the limitations of this research along with proposed questions for future research.

Two conclusions can be made from this study. The first is that remarkably detailed parallels exist among key elements in the context in which a mentor teacher works, the mentor teacher's approaches to teaching and learning, and the mentor's response to occasions for learning during the internship. The second is that differences in these key elements can account for differences in "what" was learned and "how" it was learned. The key elements found in this study are compared to the related literature.

These conclusions have implications that can be applied to teacher education programs, educational research, and professional development activities. The selection of mentor teachers could be informed by paying attention to the five elements of mentor teacher learning discussed in this study. In addition, these findings could aid in the re-thinking of internship-year assignments and activities in the teacher education program and the role field instructors play. Educational research related to mentoring, teachers learning from their own teaching practice, and the student teaching experience could all benefit from these conclusions as well. The nature of the activities investigated in this study were aligned with forms of professional development that some researchers are claiming are more effective than traditional approaches (e.g., classroom based, teacher generated problems). Thus, this study helps us to understand the nature of the learning

that takes place with these new approaches and the conditions under which the promise of these approaches can be realized.

Limitations of this study include:

- Questions about its generalizability
- The need for a more thorough investigation of the context
- The timing of the data collection

Questions for future research center around two arenas. The first concerns the generalizability of the conclusions of this study. The second deals with the effects changes in context, personal factors, and patterns of practice during activities might have on mentor teacher learning.

I conclude this study with a few comments and final thoughts.

Key Conclusions

Betty has been a mentor teacher on many occasions. She has developed ways of interacting with an intern that allow her to investigate questions that are key to her own learning. Doug was Donald's first intern. He interacted with Doug in the best way he thought possible, and his learning outcomes were moderately useful. Thus, one conclusion could be that mentors learn a lot from being mentors. All that is needed is the opportunity, and learning will follow.

Unfortunately, things are not that simple. From my research practicum, observations as a field instructor, and completing this study, I can conclude that sometimes mentors learn a lot, and sometimes they learn only a little. This is based on the context in which they work, their personal factors, and their response to the occasions for

learning that present themselves. If mentor teacher learning is to occur, an effective approach to that learning is needed.

Two conclusions can be made from this study. The first concerns the similarities that were found to exist among the characteristics of the context in which a mentor teacher works, the mentor teacher's personal factors, and the pattern of practice a mentor teacher employs when responding to an occasion for learning during the internship. The second uses mentor teachers' patterns of practice during an occasion for learning to help explain differences in "what" was learned and "how" it was learned.

Conclusion One: Remarkably detailed parallels exist among key elements in the context in which a mentor teacher works, the mentor teacher's approaches to teaching and learning, and the mentor's response to occasions for learning during the internship.

Conclusion Two: Differences in these key elements can account for differences in "what" was learned and "how" it was learned.

Parallels were noted among a mentor teacher's work with colleagues, teaching of students, and their own learning. A table in each of the data chapters noted the similarities. The characteristics of both Betty's and Donald's patterns of practice can be related to five elements of mentor teacher learning: the social environment, resource use, defining tasks, the learning process, and the nature of a satisfactory conclusion. This relationship is displayed in Table 9.

Table 9

The Relationship of Elements of Mentor Teacher Learning to Betty's and Donald's Characteristics

Element	Betty's Characteristics	Donald's Characteristics
Social environment	Creating an atmosphere of mutual trust, sharing ideas, and constructive criticism	Mutual respect and "getting along"
Resource use	Locating and utilizing relevant human and material resources	Using the textbook and self
Defining tasks	Reliance on carefully formulated researchable questions	Engaging in assigned responsibilities
Learning process	- Scaffolded collaborative work on problems - Collecting and using empirical data to develop new ideas and strategies	Learning about what works through individual active processing of learning materials
Nature of a satisfactory conclusion	- Multiple examples or tests of adequate learning - Continuing search for better solutions	- Finding acceptable activities and resources that cover expected content - Continuing search for new resources

One important outcome of the analysis is the five elements listed in the first column of Table 9. These elements are important points of contrast between Betty and Donald that had deep effects on mentor learning. The conceptual framework that was presented in the introductory chapter was used to formulate the research questions. These questions were used to guide data collection. The analysis of these data included looking for similarities among the occasions for learning for both Betty and Donald. From these

similarities emerged the individual patterns of practice, and these helped to generate the five elements in the first column. These conclusions are the direct outcome from closely investigating the "how" question, a question that has been under-investigated in the literature. It is also important to note that each set of characteristics is not only applicable to the learning of the mentor, but to the learning of their respective students as well.

Since an important outcome of the analysis is the five elements, a deeper exploration of each is warranted. Each will be described, both Betty's and Donald's approach with respect to the individual element will be characterized across contexts, and the relationship between each element and supporting literature will be explored.

Social Environment

Both mentors played an active role in developing the atmosphere in which they interacted with the students, teaching colleagues, and the intern. They helped to determine what was expected from individuals in an interaction, means of communication, resources that would be used, what the focus of the interaction would be, etc. This creation of such an atmosphere also influenced the occasions for learning.

For Betty working in her classroom, her students were expected to ask each other hard questions, be active learning members in a small group, and critically evaluate the input of others. However, they were to do so in such a way that mutual trust was created among group members and within the class as a whole. When Betty was working with her teaching colleagues, she went out of her way to open lines of communication and develop norms of trust, in some cases by exposing her own weaknesses. She shared ideas about teaching and learning. She utilized the vast array of resources available in the science department to ask the hard questions during activities in which the science

teachers engaged, and so on. Thus, it comes as little surprise that she would create a social environment based on these features when working with her intern. When working with Cathy, she pointed out her own failings and created a safe atmosphere for the free exchange of ideas and resources. In addition, they critically examined each other's ideas and practices, which supported learning for both of them.

Donald was very concerned about developing good rapport with his students. He found ways to show respect to his students and expected it in return. He pointed out examples of students acting responsibly with regard to others' feeling, beliefs, and backgrounds. Teachers at this school also acted in ways that helped them to get along. Not asking questions about a particular teacher's teaching methods was a display of respect. A parallel existed with how Donald interacted with Doug. He didn't ask Doug too many questions about "why" he chose a particular teaching technique and was very encouraging when Doug faced a challenge, but did not deeply engage with him in finding a solution. He wanted to maintain a positive working relationship with Doug and felt that through this relationship, Doug would pick up on some of his good points which would support Doug's learning to teach.

One measure of social environment at the school level is the extent to which a professional community exists. It has already been noted that Newmann and Associates (1996) described the characteristics of professional community as being a shared sense of purpose, a focus on student thinking, collaboration, reflective dialogue, and deprivitizing practice. Evidence from the *High School & Beyond* national survey data presented by Bryk and Driscoll (1988) reinforces and extends findings from a long line of field-based research on conditions of effective schools showing that schools relatively high on

dimensions of professional community [such as consensus among staff members on school goals, principal leadership, teacher cooperation and extended roles, high staff expectations for student achievement, and parent involvement (Purkey & Smith, 1983)] are higher on measures of student academic achievement and retention.

However, Talbert, McLaughlin, and Rowan's (1993) work on social environment brings to the surface some very important points, if teaching for understanding is the goal. They suggest that an argument relating the presence or absence of professional community to particular kinds of teaching and learning in classrooms is problematic for a variety of practical reasons. First, their research suggests that strong schoolwide communities are rare and often depend on very special conditions of client and staff selection or unusually small size. Second, whether the school or department forms the unit of community, value consensus within a faculty gives no guarantee that the values will support teaching and learning for understanding. Third, they found that opportunities for teachers to learn and to receive collegial support for new teaching practices often exist outside the school. While the existence of such extra-school contexts of teachers' professional communities does not challenge the potential role of school community in promoting teaching for understanding, it may be that such professional networks and discourse communities are more important than schoolwide community in diffusing and enabling teaching for understanding in U.S. classrooms.

Resource Use

In this study, resources are defined not only as material resources (e.g., books, money, time), but they also include human resources (e.g., experiences, beliefs, knowledge, habits of mind) and social resources (e.g., collaboration, shared sense of

purpose, reflective dialogue). Sometimes in an occasion for learning resources are available, but not utilized. At other times, new resources are generated from existing resources during the occasion for learning.

In Betty's case, she had many resources available to her and she used them in effective ways to enhance her own teaching practices. She had over 25 years of teaching experience and had been a mentor to an intern about one dozen times. She had a solid background in biology and continued to participate in conferences and workshops to increase her subject matter knowledge. Her colleagues shared her concern over finding ways to teach key science concepts more effectively, and many of the activities in which they engaged had this as a goal. These teachers accumulated a vast set of material resources that were utilized in many of their interactions. The experiences of Betty's students played an active role in shaping the events of a lesson, and this helped them to make connections between science and their world. Betty scaffolded many of the interactions with Cathy by asking purposeful questions or introducing material resources that supported both of their learning.

Unfortunately, Donald was not teaching in a resource rich environment. The majority of the available material resources were associated with the textbook. One set of equipment was available for some demonstrations, but typically enough sets were not available for student laboratory work. Students worked independently to make sense of the science content. Science teachers largely kept to themselves, so ideas were not readily shared. It was up to each individual teacher to find the approach to teaching that worked best for him or herself. Interactions with Doug centered around textbook driven activities, and Donald felt that Doug needed to develop these activities on his own since that is what

he would be expected to do when he had his own classroom. Thus, this view limited their interactions where they could deeply probe underlying assumptions and purposes of rich and meaningful activities.

Spillane et al. (2001) examined how school leaders bring resources together to enhance science instruction when there appear to be relatively few resources available for it. These authors argued that leading change in science education involves the identification and activation of material resources, the development of teachers' and school leaders' human capital, and the development and use of social capital. This argument is echoed by Gamoran et al. (2003).

Obviously technology has vastly increased the number and variety of material resources available to teachers. By using Internet-based resources to support instruction, one is likely to find the desired relevance, real world content and opportunities for communication. The Internet provides an easy means of electronic communication, supports staff development opportunities with discussion listserves, and provides access to raw materials that can be used for instruction (Cowles, 1997).

With respect to human resources, it is not only important for a teacher to utilize his or her own expertise and experiences, but also to access that possessed by colleagues. In addition, student ideas, feelings, and backgrounds should be considered as well. Fidishun (2000) puts forth the notion that reducing student anxiety, being aware of student expectations, utilizing student experience, encouraging active participation, making lessons relevant to student needs, and assisting student growth are important in many instructional approaches.

Finally, associated with social resources are community norms, practices, and modes of communication. Pourdavood and Fleener (1997) summarized a research study examining the dialectical relationship between the evolution of a dialogic community and changes in classroom sociocultural norms. They found that as the community evolved, teachers' shared ideas and renewed confidence clearly affected risk-taking by students and changes in classroom practices and procedures. In addition, maintaining open and honest communication enhanced teachers' efforts to create a humanistic, safe, and caring classroom for their students.

Defining Tasks

What the mentor teacher spent time doing was mostly determined by that individual. Each of the two mentor teachers used a different means in determining what she or he would spend time and effort on. Specific criteria informed this determination.

Betty organized many of the students' activities during a lesson around carefully constructed questions. Addressing these questions required students to gather data and engage in discussions with their peers about analysis procedures and interpretations. Many of the interactions with her teaching colleagues were centered around a specific researchable question of student learning. Patterns noted from responses on assessments, student questions during lessons, and journal entries were common sources of these questions. Betty also found this type of question useful when creating situations for her and Cathy to explore.

For Donald, the assigned responsibilities he viewed his students and himself as having dictated many interactions. Enacting the procedural tasks of teaching was his primary role. Students were expected to complete the activities related to the content and

show respect to one another and their school. The focus of many of Donald's interactions with other teachers was based on the procedural tasks of teaching. He was looking for resources that could assist with these tasks and also those that contained information useful to students while "processing" scientific information. Many of his interactions with Doug also centered around the textbook and the procedural tasks of teaching. Thus, much of his learning from these occasions was limited to these two arenas.

The tasks in which teachers engage are largely determined by the individual's philosophy of teaching and learning along with the nature of their teaching practices. For example, if teaching for understanding is the goal, Wiske (1998) contends teachers need to, among other things,

- Determine generative topics that are central to a domain or discipline, accessible and interesting to students, interesting to the teacher, and connectable.
- Create understanding goals that define more specifically the ideas, processes, relationships, or questions that students will understand better through their inquiry. "Understanding goals are most useful when they are explicitly defined and publicly posted, when they are arrayed in a nested structure with sub-goals leading to overarching goals, and when they are focused on key concepts and modes of inquiry in the relevant subject matter" (p. 70).
- Design understanding performances that are both generative and challenging. Features of these understanding performances include "messing about", which is inquiry not yet structured by disciplined-based methods and concepts; guided inquiry, which engage students in using the ideas or modes of inquiry that the teachers sees as central to understanding the identified goals; and culminating

performances, which may be similar to the projects that many teachers assign as final products to complete a curriculum unit.

- Enact ongoing assessments that are based on public criteria related to understanding goals, take place frequently, are conducted by students as well as teachers, and inform planning while they gauge students' progress.

In addition, the *National Science Education Standards* (NRC, 1996) state that the tasks of teaching need to encompass new strategies. These include (a) understanding and responding to individual student's interests, strengths, experiences, and needs; (b) selecting and adapting curriculum; (c) focusing on student understanding and use of scientific knowledge, ideas, and inquiry processes; (d) guiding students in active and extended scientific inquiry; (e) supporting a classroom community with cooperation, shared responsibility, and respect; and (f) working with other teachers to enhance the science program (p. 52).

Learning Process

Both Betty and Donald found ways to learn from the experience of being a mentor to an intern. Each used the context in which he or she worked in effective ways. Their own theory of learning also influenced what and how each learned.

Scaffolded collaborative work on problems was a key feature of Betty's learning and the learning by her students. Her students spent a good amount of time in small groups working on sophisticated problems where they had collected data and were engaged in an analysis that many times led to an elaboration of ideas. She sought the input from her teaching colleagues to work on the tasks she defined. This input many times took the form of artifacts of student work, and the discussion that ensued would

lead to teaching strategies that could be attempted. She created situations where she and Cathy could work together on problems concerning teaching and learning with each feeling that her input would be considered. Their conversations typically involved the suggestion of potentially fruitful ideas. In addition, Betty also spent much time reflecting on her teaching, student performance, and the dialogue in the classroom.

Independent work utilizing appropriate information helped determine solutions to problems for Donald's students and for himself. Students many times worked independently on assignments from the textbook during a lesson. They were expected to use the information contained in the text to answer questions that had been posed to them. As we saw in the previous chapter, Donald worked independently to design a new approach for teaching his AP physics class. He used his experience from teaching the class the previous year and textbooks in creating this new strategy. He expected Doug to "wrack his brain" in an attempt to devise a solution to a teaching problem. By learning through an individual means, Donald was not privy to others' ideas and ways of approaching problems. This limited what he learned to his own private domain.

Related to the individual teacher's philosophy of teaching and learning is how she or he views the learning process. Traditionally, learning was seen as the absorption of knowledge that was transmitted from a more-knowledgeable other to a novice. Lecturing is a common teaching strategy in this view, as is the reproduction of the knowledge administered from the teacher on an assessment. However, using the results of findings from research on human learning over the past 30 years, our views of how effective learning proceeds have shifted from the benefits of diligent drill and practice (strategies associated with traditional teaching) to a focus on students' understanding of important

ideas and concepts and application of knowledge (Bransford et al., 1999). Research findings concerning memory and the structure of knowledge, analysis of problem solving and reasoning, early foundations, metacognitive processes and self-regulatory capabilities, and cultural experience and community participation have informed our conceptions of learning.

Once again using teaching for understanding as an example, Cohen et al. (1993) suggest that the core principles of this approach include:

- A conception of knowledge as constructed by the learner and therefore situated in the context of prior knowledge skills, values, and beliefs;
- A conception of teacher as guide, as co-constructor of students' knowledge; and
- A conception of the classroom as a community of learners, in which shared goals and standards, an atmosphere of mutual trust, and norms for behavior support students in taking the risks and making the sustained efforts entailed in serious learning (p. 169).

Research on teacher thinking has shown that teachers' beliefs about teaching and learning processes play a significant role in determining the nature of the teacher's purposes in the classroom and directly affect many features of their professional work, including lesson planning, assessment, and evaluation (Bryan & Atwater, 2002).

Nature of a Satisfactory Conclusion

Both mentor teachers had ways of determining when they had gleaned all there was to be gained from an occasion for learning. They each had ways of implementing their new learning outcomes to their teaching.

Betty was rarely satisfied with her teaching practice. She was always looking to improve. She never felt she "had it right." She was always looking for more examples to be used with her students so that connections could be made by all of her students, not just the academically gifted. At times her work with her teaching colleagues would re-visit teaching strategies that were already in place to look for not only more examples, but ways of interconnecting them that made sense to students. Cathy's experiences and ideas were a wonderful source of new examples to enhance Betty's teaching practice. They spent much time in planning sessions discussing new examples.

The nature of Donald's teaching practice was such that many different resources were needed as sources of information that students could process. He was always looking for material resources around the school that could assist with this key feature of his theory of learning. If he went to visit another teacher's classroom, I often noticed that he would ask about a demonstration that was set up or about worksheets that were available with the goal of gathering more resources in mind. One of Donald's reasons for becoming a mentor to an intern was his hope that the intern would bring with him or her ideas for more resources. However, in order to be useful, these resources needed a direct connection to the science content that was being covered in the class.

The Third International Mathematics and Science Study investigated math and science education in many countries. It was concluded that science teachers in the U.S. have demanding working conditions. Many stakeholders make demands on science teaching practices. To respond to these many, varied, and many times competing demands some science teachers "satisfice". "This suggests that teachers use an approach of 'satisfying sufficiently' and making choices that are 'good enough' under their

working conditions" (p. 78) and also in professional development experiences or other occasions for learning. According to Schmidt et al. (1997), "They do not try for the absolute best decision. Those who satisfice choose the first decision among the alternatives considered that seems good enough. Thus, decisions are made based on the order in which a teacher considers alternatives. The teacher's sense of responsibility shapes the criteria of what is 'good enough.' In the end, teachers rely on what feels comfortable and appeals to them" (p. 78-79).

Learning Outcomes

Because they approached occasions for learning so differently, Betty and Donald learned very different things from these occasions. These differences in approach to an occasion for learning can be used to help explain disparities in "what" each learned and "how" each learned.

Betty learned how to address a commonly held student misconception about mitosis. This was a specific researchable question that she identified based on student responses on a test, questions asked in class, and journal entries. She now had a strategy (although in typical Betty style felt that improvements could be made to this newly found strategy even though it had been tried in multiple classrooms) for teaching her students about the life cycle of a cell. This strategy was developed by collaborating with her intern, and it was modified using data gathered from student work on the activity. A critical examination of the pieces of the strategy and their anticipated influence on student learning played roles in its development.

Betty also learned about how to more effectively construct an assessment that would make student reasoning about key concepts and ideas visible. If she used Cathy

(who could be considered a knowledgeable student) to pilot the test, what would she notice about how Cathy approached specific problems that would help her make the questions more clear and elicit the responses she was hoping for? When taking the test that Betty had designed, Cathy trusted that even if she made mistakes, these mistakes would be helpful in Betty's determination of effective test questions. Each question was carefully scrutinized by closely examining the wording and possible interpretations students might have. In the process, other problems were created that could be used on subsequent assessments.

Donald was in search of efficient ways to cover the content in AP physics. He felt that if he used technology (something most students enjoyed using and were adept at), an atmosphere in which students were comfortable and would work together would be established. Students could process the information found in textbooks on a particular topic while creating a website. However, when it came to the presentations on the various physics topics, at least some students felt that Donald was not engaging in his assigned responsibility of directly instructing them. They became frustrated. By examining the webpages, Donald came to the conclusion that students had not "processed" the information in the ways he had hoped. Thus, Donald learned that the creation of websites could be a potentially useful activity in covering the content, however, modifications to his current strategy were needed. This is an important outcome since rarely in teaching does something work as hoped on the first attempt and ways of modifying new strategies need to be determined.

While another occasion for learning was discussed in Donald's chapter, it was shown that a learning outcome did not emerge from this situation. However, the five

elements of mentor teacher learning help us understand why this was the case. Donald was very concerned about maintaining the positive relationship he had established with Doug, so he did not push him too hard or ask too many difficult questions. Instead, he provided suggestions for activities that Doug could try. In his view, he was being a good mentor by creating a situation that represented the kind of work Doug would be expected to do on his own the following year. Thus, an activity that Donald could use with his students was not created, nor was an understanding of how to help students comprehend the concept of convection. Once again the fact that Donald did not generate the question around which this occasion for learning revolved undoubtedly played a role in this occasion being less successful than others.

Other Occasions for Learning Were Present During the Internship

The four occasions for learning discussed in the data chapters were not the only occasions for learning present during these two internships. Even though it falls outside this analysis, there were other occasions for learning in which both Betty and Donald found themselves where these characteristics played a role. Both were making choices (perhaps unconscious) based on their personal factors and the context. So while the choices of each were different, the occasions were nonetheless remarkably similar. A partial list of these occasions for learning includes:

- Choosing a new activity for an elective course
- Their students showing evidence of not understanding
- The intern needing help with ideas for a lesson
- Reflecting on the outcome of a new activity
- Observing the intern or a novice teacher teaching a lesson

- Getting help from another teacher
- Engaging in initial discussions with the intern at the beginning of the internship

Let us use an example from above to briefly examine how their choices of what to say, do, and pay attention to are different; what they learned was different; and how their different choices and learning can be explained in terms of differences in personal factors and the context. The chosen example is "students showing evidence of not understanding," since this is closely related to teaching for understanding.

Students showing evidence of not understanding. Betty had established a classroom environment where the asking of questions was encouraged, particularly those questions where students challenged each other's interpretation of data (constructive criticism). Yet students did not feel threatened by these questions since it was understood that this was an expectation of students and that these questions would be a benefit in their learning (mutual trust). On one such occasion, students were dissecting a pig's heart in small groups. The questions posed in the groups opened up the students' reasoning to Betty (collecting data to develop new ideas of how to help students learn). Betty addressed these questions by posing her own questions to the students. She felt that if she asked the right questions, she could scaffold the dialogue in such a way that the students would eventually come to their own realizations that answered their questions (scaffolded collaborative work). Betty's questions were based on her vast experience in teaching biology, on relevant material resources (like the pig's heart), and on the outcomes of related discussions with Cathy (resource use). The dialogue not only helped the students come to an understanding of the structure and function of the pig's heart, but it also helped Betty understand where student reasoning may be going astray, or a

misconception may be unearthed during her reflective conversations after the lesson with Cathy (which might assist in the formulation of a researchable teaching question). Experiences such as this when strung together over time helped Betty devise examples used in assisting students with making connections between prior and new knowledge (a learning outcome from skillfully working with students and paying close attention to their questions). Implementing these new ways may very well create new researchable questions related to teaching and learning.

Donald made time for student questions during his lessons. Many of these questions were procedural in nature, and Donald did a nice job in clearly explaining the proper procedures to students (showing mutual respect). When these questions were related to student understanding, as they were one day when a student asked about the formation of volcanoes, his response was to locate another resource for the student to use, in this case a section from an old textbook (a reliance on the textbook). This resource was made available only to the student who asked the original question, and it was left to that individual to make sense of the new information. Donald also asked Doug if he knew of other resources that might be helpful in this situation, and Doug suggested a web-based activity. By adding another resource, Donald was adding more information to be available for individual "processing" (individual active processing of learning materials). Each individual in this exchange was engaging in his or her assigned role: the student asked a question that was within the realm of the questions students were expected to ask, and Donald responded in a way that is typical of the actions of a science teacher at this school (engaging in assigned responsibilities). Their relationship is based on these expected norms, and each is respectful of the other's actions (getting along). Since the

student used the new information in a way that made sense to her, Donald has found another resource to be used in his covering of the content (a learning outcome - finding an acceptable resource that covers expected content).

Implications

There are several implications of the conclusions discussed earlier. The five elements of mentor teacher learning have the potential to play important roles. There are implications for teacher education programs, for educational research, and for professional development. Each will be elaborated below.

For Teacher Education Programs

If a teacher education program is in the position to choose among a pool of potential mentor candidates, paying attention to the teacher's theory of learning and teaching will be helpful. Many aspects of this theory are visible in his or her teaching practices. Thus, spending time in the potential mentor's classroom observing the teaching of lessons and the interactions with students would be an important step. What kind of an educational environment has been established in this classroom? How are the tasks put forth to students designed? What resources are being used and in what ways? What teaching strategies are being employed? How are students expected to learn? How are examples utilized in the lesson? By asking questions such as these, a reasonable determination of the nature of "what" could be learned by the mentor teacher can be made and some insight can gained on "how" pieces of the internship might be used to enhance the mentor's teaching practices. This determination could also be useful in selecting desirable mentor teachers.

Investigating occasions for learning was of vital importance to this study of mentor teacher learning. Teacher education programs can assist with this learning and the learning of interns by developing internship-year course assignments that allow the two individuals to collaborate in meaningful ways. For example, a variety of topics for assignments could be posed to the mentor/intern pair and allow them to choose which is most relevant to their learning needs. One such assignment might be structured around the examination of student questions during a lesson. An assignment suck as this could be explored through (a) shared inquiry, in which the mentor and the intern define and conduct a single teacher inquiry project together; (b) parallel inquiry, in which the mentor and the intern support each other in their individual endeavors as they simultaneously conduct individual teacher research projects and then share their findings; or (c) inquiry support, in which the intern takes full ownership of the inquiry project, and the mentor takes an active role in helping the intern formulate questions, design the project, collect data, and analyze data (Silva & Dana, 2001).

No matter if it is a formal assignment or not, teacher education programs should develop supports for learning by both the intern and the mentor. By following the principles of action research both the novice and experienced teacher would gain valuable experience in identifying key issues and problems associated with teaching and learning, data collection and analysis, and communicating findings.

> One implication of collaborative action research for mentoring practice is that having sustained, substantive conversations during student teaching influenced the practice of both a student and mentor teacher. The very nature of action research implies a spiraling process of thinking, planning, acting, reflecting, and

revising. In typical mentor/student teacher relationships, dialogues are often limited to minutes before and after school, or during lunch and planning. During these times, pressing issues often supersede efforts to engage in critical dialogue. This case provides evidence for the importance of having blocks of time to talk together and to spend this time asking questions, sharing agendas, and supporting learning (Stanulis & Jeffers, 1995, p. 22).

Collaboration on an action research project should be exciting, intense, fascinating, deeply gratifying, and, above all, mutually beneficial to the mentor, intern, and students in their classroom. The project should challenge mentors and interns to become more deeply involved in the business of learning to teach by questioning current practices and experimenting with new curricular and teaching practices. While recognizing that the intern and mentor are at different stages in learning to teach, working with a classroom based issue or problem using action research principles can create new possibilities for dialogue, reflection, brainstorming, planning, curriculum-making, assessment practices, and teaching.

Thus, the charge to teacher education programs would be to design activities around carefully devised researchable questions. At present, collaboration is only encouraged by some teacher education programs. With many assignments, the benefits that the mentor teacher can accrue are not obvious or not compelling. By designing assignments where deep collaboration is needed by both individuals, reflective dialogue and the deprivatization of ideas and beliefs can play roles in enhancing the teaching practices of both the intern and the mentor. A variety of material resources from the school, the students' ideas and experiences, Internet resources, resources from teaching

colleagues, etc. should all play a role in these assignments. Also an aspect of engaging in constructive criticism should be built into each assignment. It may also be possible to allow the mentor teacher to earn graduate credits.

Re-thinking the role of the field instructor can also be influenced by the conclusions from this study. This person could be prepared by teacher educators to act as more of a facilitator for the learning of both the intern and the mentor. To do this, she or he needs to establish mutual trust among the mentor, intern, and him or herself by openly communicating encouragement and concerns in a non-threatening manner. She or he needs to scaffold a three-way dialogue among mentors, teacher candidates, and program staff. The field instructor should skillfully create occasions for learning around researchable tasks that would benefit both the novice and the more experienced teacher, instead of just providing feedback to the intern. She or he needs to become familiar with all of the resources available to the mentor teacher and look for creative ways in which these resources can be incorporated into an occasion for learning. In many teacher education programs, the mentor and novice avoid the deep issues of teaching in order to preserve relationships (Hawkey, 1997), an influence in Donald's relationship with Doug. Field instructors can be in a position to develop the norms and practices that would allow the mentor and intern to ask the tough questions that are needed in many occasions for learning.

The bottom line for all of these implications is that by setting the stage for involving the mentor teacher in meaningful activities where his or her own teaching practices can be enhanced, teacher educators will not only be providing an effective

means of professional development for the mentor, but will also be providing meaningful occasions for learning for the intern. This would create a win-win situation.

For Educational Research

Much of the research that has been conducted on understanding mentoring has focused on the one-way path of benefits for the novice. This is particularly true when considering the research related to the mentoring of a student teacher or intern. Ten studies were found that discussed any benefits accrued by the mentor during the student teaching experience, and only a couple of these focused on the mentor's teaching practices. I believe my study has shown that we need to begin to more strongly consider the mentoring experience as a two-way interaction with potential benefits going in both directions. Occasions for learning that benefit both parties need to be studied closely, and their characteristics need to be analyzed. What is the nature of the interactions between a mentor and intern? What resources are available? What resources are being used? Are any new resources being generated as a result of these interactions? If so, what are they, and how are they generated? How are interactions focused? What does the mentor teacher seem to pay attention to? What ideas are acted upon? What components of the science department make their way into playing a role in the occasion for learning? What are the learning outcomes? All of these questions deserve attention if mentor teacher learning is a goal.

Recently, more research has been conducted on teachers learning from their own practice. I believe this is a step in the right direction. My study can be helpful to researchers in this realm by not only raising the awareness that these five elements of mentor teacher learning need to be considered, but also that more needs to be made of

examining what teachers pay attention to. This important factor is rooted in the teacher's theory of teaching and learning and in their teaching practices. By better understanding what teachers pay attention to and why, advances can be made in understanding what and how teachers learn from their own practice.

As was mentioned above, the student teaching experience can be influenced by the conclusions of this study. A corresponding influence on the research associated with student teaching also exists. By better understanding the role and function of the five elements of mentor teacher learning, experienced teachers can improve their own teaching practices at the same time as more effective student teaching experiences occur. On a related note, studying intern evaluation systems that promote the professional growth of both the novice and the mentor instead of acting as a hindrance to teacher learning would be an important step.

For Professional Development

Being a mentor teacher as a form of professional development takes into account many of the features associated with our current understandings of effective professional development (Garet et al., 2001). For example, it is classroom based, it takes place over an extended period of time, and the activities, problems, and issues that become the focus of learning can be determined by the teacher. Thus, being a mentor teacher seems to hold some promise as an effective form of professional development.

The importance of the mentor teacher determining the questions or issues that will be the focus of learning, instead of someone else, cannot be overstated. As was mentioned before, the adult education literature shows that this is important, and it was also important in this study and a study by Van Zee, Lay, and Roberts (2003).

One difference between Donald's occasion for learning involving convection and the other occasions was the fact that Donald did not generate the question around which this occasion was focused. Thus, a motivating force or a force that generates change was absent (Gauvain, 2001). Silva and Dana (2001) found that teachers who developed questions about their practice were more likely to generate effective learning outcomes. The subjects of these questions included a focus on (a) some aspect of pedagogy, (b) a particular child or children in the classroom, (c) one's own teaching beliefs, and (d) the curriculum.

However, further study is needed, and the five elements of mentor teacher learning can play an important role. First, an element of constructive criticism must be a part of a supportive environment where learning is to take place. Mentor teachers must challenge one another, be able to justify their beliefs and interpretations of data and events, and ask hard questions of their interns and colleagues. At the same time, they need to be respectful to one another and be willing to open up their teaching practices and ideas to expose both strengths and weaknesses. Resources that the mentor teacher will find useful and tasks that have the potential of producing effective learning outcomes must be available and utilized. Mentor teachers should be given opportunities to collaboratively work with other mentor teachers to address issues related to teaching and student learning. The formulation of new ideas, strategies, and questions for future research needs to be the goal of specific tasks and this form of professional development as a whole.

Limitations

Like any research study, this one has limitations associated with it. There are three that seem to play a more important role than others.

How Unique Were Betty and Donald's Experiences?

How generalizable is the experience of Betty and Donald? For each, the argument was made that characteristics of the context in which they worked and their individual personal factors affected, in quite detailed ways, the pattern of practice used in responding to an occasion for learning. However, what is not known is how widespread this influence is. Are Betty and Donald exceptions to an overall pattern among teachers that context and personal factors do not influence how a teacher responds to an occasion for learning? Or are they two of many teachers who have a relationship among the three planes of focus? This was a study of the *means by which* a mentor teacher learns from an occasion for learning present during an internship. This study did not set out to make any claims about the generalizability of the findings (and in the end, none can be made).

For example, Betty had been a mentor teacher to about one dozen interns and had taught in the university's teacher education program. Doug was Donald's first intern. However, Donald was familiar with the teacher education program since he had hosted a senior the year before and was privy to the interactions of other science teachers' work with their interns from previous years. He was taking a master's level course from this department while data were being collected. Thus, data were collected on two teachers who were rather familiar with the teacher education program, with one having lots of mentoring experience and one having very little. However, data were not collected on

(for example) a mentor teacher with *some* mentoring experience and *limited* knowledge of the university's teacher education program.

An Incomplete Study of the Context

The study of the context at Heisenberg and Einstein High Schools was limited. Data were collected by conducting interviews with some of the science teachers. Observations were made only of events that were readily available to a visitor at a school, like informal interactions among faculty, student interactions during science lessons, resources available, and so on. I did not interview any administrators to get their perspective on the science department. I did not observe any other science teachers teaching a lesson (although I was a field instructor at Einstein High School for two years, so I have a sense of how many of the science teachers teach). I did not attend any science faculty meetings. Gaining a better sense of the context may enlighten the conclusions of this study.

The Timing of Data Collection

Data were collected for four months during the spring term. By this time in the internship, the relationship between the mentor and the intern was well established. Norms of communication had been set, and particular patterns of interaction were expected. What happened during the beginning of the internship when norms and patterns of practice were being determined? In addition, I made visits to the school only a few times per week (at most). Were there important interactions between the mentor and intern that took place when I wasn't there? Undoubtedly so. In addition, the occasions for learning were all centered around the interactions between the mentor teacher and her or his intern. Other important interactions may have been missed. For example, the timing

of my data collection was such that I did not observe the interactions among the mentor, intern, and field instructor. Studying these interactions might very well have fleshed out some of the understandings developed in this study or added new understandings.

Questions for Future Research

I have found the results of this study to be very interesting. They have led me to consider other questions for future research. These questions fall into two categories:

- those dealing with how generalizable the results of this study are and
- those dealing with changes in one of the planes and any effect these changes might have on the other two.

How Generalizable Are the Results of This Study?

Among secondary science mentor teachers. Originally, there were five research questions to this study. The fifth question was to compare the experiences of Betty and Donald to other secondary science mentor teachers. This comparison was to be made on the basis of learning outcomes, contexts, and activities. A survey was created and sent to the 49 other secondary science mentors and a follow-up interview was conducted with seven of these mentors and their respective intern. Unfortunately, these data were not too useful in addressing the "what" and "how" questions of this study.

If data on a variety of secondary science mentor teachers is to be collected to conduct a comparison among their patterns of practice, the in-depth data collection that was utilized in this study is not practical. A different means of data collection must be devised. I believe that the elements displayed in the first column of Table 9 (social environment, resource use, defining tasks, learning process, nature of satisfactory conclusion) can be useful in thinking about the type of data that are needed. Thus, I need

to learn more about how to construct survey items that can be used to capture important data associated with mentor teacher learning. I also need to learn more about the ways in which to collect relevant data from a brief telephone interview. I want to use these new data collection methods to address an adaptation of my original fifth research question:

How does the two focus mentor teachers' learning about the teaching cycle compare to other secondary science mentor teachers' learning?

a) What resources play roles in mentor teacher learning? Are there resources available that are underutilized? Are any new resources generated as an outcome from an occasion for learning?

b) How is the occasion for learning focused? Who sets the agenda? Whose ideas are acted upon and how? How does a mentor's theory of learning influence the occasion for learning? What do the mentor teacher and others do?

c) What is the nature of any learning that takes place during an occasion for learning? Does collaboration play a role? If so, how?

d) What learning outcomes develop for the mentor teachers? How do they determine when they are finished learning from an occasion for learning?

Outside secondary science. Are the results of this study applicable to other subject matters? Is there something about the nature of teaching secondary science that makes a relationship among context, personal factors and patterns of practice used in responding to occasions for learning during an internship more likely than in other subject matters or at the elementary or post secondary levels?

Application to activities not associated with being a mentor teacher. Are the results of this study applicable to other activities associated with a teacher learning in his

or her school setting? For example, would the results of this study provide any insight into the patterns of practice used by a teacher while working with students individually or in small groups? Or when a teacher is engaged with another form of professional development?

Changes in Patterns of Practice

1. If there are changes made in one of the planes of focus, does this have an effect on the other two? If so, in what ways?

a) Does a change in context affect the patterns of practice a mentor teacher uses in responding to an occasion for learning during the internship? For example:

i. If a science teacher moves from one school to another, does this influence his or her patterns of practice? If so, in what ways?

ii. If the school changes from a seven or eight period system to block scheduling, does this influence his or her patterns? If so, in what ways?

b) What, if any, effect would a change in context have on the personal factors of the science teacher?

c) Does a change in personal factors affect the patterns of practice a mentor teacher uses in responding to an occasion for learning during the internship? For example:

i. If a science teacher who has taught using a traditional approach in the past completes a master's degree program based on teaching science for understanding and implements this approach in her or his classroom, does this influence his or her patterns of practice? If so, in what ways?

ii. If a science teacher has some kind of a transformational experience that changes his or her theory of teaching and learning, does this influence his or her patterns of practice? If so, in what ways?

d) What, if any, effect would a change in the science teacher's personal factors have on the context in which she or he teaches?

2. In what ways can a mentor teacher change her or his pattern of practice used to respond to an occasion for learning during the internship if she or he determines that her or his current practices are not effective in developing the kinds of learning outcomes she or he desires? What influence would any changes in patterns of practice have on the context and/or the science teacher's personal factors?

Final Thoughts and Comments

I found the work on this study to be very interesting. Gaining insight into how a science teacher learns from certain occasions allowed me to make comparisons with how I learned from similar situations. It also allowed me to investigate questions about the interactions between a mentor teacher and an intern that I had formulated during my days as a field instructor. It provided me the opportunity to reflect on my experience as a student teacher and on the interactions I had hoped for with my mentor teacher.

The "how" question was the key to this study, not only because it has been under-investigated in the literature, but also because of my interest in pursuing it, and the important role it plays in mentor teacher learning. To examine this question, underlying assumptions, causes, and elements needed to be identified and utilized to make some sense of how a mentor teacher learns from occasions for learning. In addition, the quest for determining the patterns that emerged from the context, personal factors, and

activities was essential in developing insights into the complex situation of examining how someone learns.

Conducting this research study taught me the need for powerful frameworks in helping us understand complicated circumstances. On the surface, a critic could claim that it is obvious that context and personal factors would in some way influence the patterns of practice a mentor teacher uses to respond to an occasion for learning during the internship. However, through the careful application of this conceptual framework to specific occasions of mentor teacher learning, the explanatory power of this framework was shown. By using a deep level of application, the detailed parallels among the characteristics of the context, personal factors, and patterns of practice used in the activities became apparent. This led to interesting and important insights.

I learned much about the processes associated with conducting educational research. In particular, I learned about the importance of "playing with" or "mucking about" in the data. The revisions I made to every chapter required me to re-think how I was using the data and search for alternative ways of analyzing and organizing it. I also learned about the important role "passion" plays in research. One must have a deeply held feeling that the questions that are being examined are worthy of enormous amounts of time and effort. The work is intense, and sometimes clear interpretations and appropriate next moves are elusive. Dedication, determination and persistence are needed if helpful results are to be produced.

APPENDICES

APPENDIX A

Focus Mentor Teacher Interview Protocol

(Given at the beginning and end of data collection)

1. What do you consider to be the founding principles of teaching? If you had to write a book describing the principles that teaching should be built on, what would those principles be?

2. When you picture a good learner in your mind, what characteristics of that person lead to believe that they are a good learner?

3. What learning in your classroom do you think will be valuable to your students outside the classroom environment?

4. What science concepts do you believe are the most important for your students to understand by the end of the school year?

5. How do you want your students to view science by the end of the school year?

6. What do you believe are your main strengths as a teacher?

7. In what areas would you like to improve as a teacher?

8. How would you compare your approach to teaching this year to last year's approach? Why is it the same/different?

APPENDIX B

Nodes for Dissertation Analysis

10 What is learned

- 10 About students
- 20 About content knowledge
- 30 About the teaching cycle
  - 10 Planning
    - 10 Clarifying the goals and objectives
    - 20 Selecting content and examples
    - 30 Selecting teaching strategies and activities
    - 40 Selecting assessment strategies
    - 50 Planning for expected student activity
  - 20 Using teaching strategies
    - 10 Determining the level of responsiveness to students' needs and desires
    - 20 Selecting strategies that the teacher believes are useful
    - 30 Determining the level of interaction between teacher and students and among students
  - 30 Conducting assessments
    - 10 Defining the degree of connection with goals and objectives
    - 20 Determining the nature of the assessment
      - 10 Dichotomous

20 Quantitative

30 Qualitative descriptions

30 Creating the methods used for the assessment

40 Creating and suing data collection strategies

50 Creating and implementing forms of analysis

60 Determining the methods of using information from the analysis

70 Determining the ways of communicating these findings to interested individuals

40 Evaluating one's own performance

10 Evaluation duration

10 During a lesson

20 After a lesson

30 Over longer periods of time

20 Defining the purpose of the evaluation

30 Defining the nature of the evaluation

10 Analytic and evidence based

20 Vague and global

40 Determining what counts as evidence for the evaluation and its relative value

50 Becoming clear on the role of students in the evaluation

40 Ways in which learning outcomes become a part of the teacher's practice

20 How learning takes place

10 Activities an individual can do independently

20 Activities an individual is not proficient in doing independently or with support

30 Activities in the zone of proximal development

10 Community / institutional context

10 Bureaucratic policies and practices of the school

20 Philosophy of administrators

30 Influential sub-groups whose ideas inform teaching practices

40 Involvement of parents

50 Culture of the students

60 Norms and expectations of teacher behavior

70 Expectations of the teacher education program

80 Role and expectations of the science department

10 Shared sense of purpose

20 Collaboration

30 Focus on student learning

40 Deprivatized practice

50 Reflective dialogue

60 Membership in the community

90 Role of technology

20 Local learning community and activities

10 Responding to occasions for learning

10 Planning

20 Teaching

30 Assessment

40 Reflection / Revision

20 Actions taken to support mentor teacher learning

10 Cultural tools / resources used

20 Participants in the activity

30 Nature of the activity

40 Ways of focusing the activity

30 Personal factors of the learner

10 Nature of the focus mentor teacher's teaching practices

20 "Frame" used by the mentor teacher

10 Role of the mentor teacher's experience

20 Mentor's perception of the purpose of the internship

30 Mentor's perception of his or her needs as a learner

40 Mentor's determination of benefits/costs with learning (or not learning)

30 Expectations

40 Motivation to learn

50 What dispositions does the mentor teacher possess

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