CONCEPTION PATTERNS RELATED TO EFFECTIVE TEACHING OF PRESERVICE SECONDARY SCIENCE TEACHERS AT THE BEGINNING OF A SCIENCE METHODS COURSE.

by

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ABSTRACT

CONCEPTUAL PATTERNS RELATED TO EFFECTIVE TEACHING
OF PRESERVICE SECONDARY SCIENCE TEACHERS
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The study's purposes were to document concepts about teaching held by secondary science preservice teachers as they began a methods course, and to assess different data sources as bases for identifying concepts. Twelve methods course students and the instructor were participants of this descriptive study.

A cognitive science theoretical framework was used to coalesce subjects' held concepts about teaching in relation to five issues: 1) the nature of a teacher's work, 2) the problem defined for course interpretation, 3) an idealized view of teaching based on dispositional type knowledge about teaching, 4) a realistic view of teaching based on propositional and procedural types of knowledge, and 5) the determinants of a course curriculum.

The subjects' held concepts were determined from pre- and post-course clinical interviews which included knowledge application tasks, the planning of an inquiry science lesson with a recall interview, and a microtaught lesson with sixth grade students.

The subjects' conceptual patterns were diverse in relation to each

issue and in comparison to the expert's effective teacher patterns. These patterns defined a relative scale of descriptors which were used to assess the potential effectiveness of the teacher. These were based on a subject's thoughts as they related to the specific and differing dispositional, propositional and procedural knowledge types of the subject and the expert. The scale showed a system for determining gaps in knowledge about teaching: between a subject and the expert, and within the subject's dispositional or judgement-making knowledge base and the propositional and procedural or decision-making knowledge base for teaching. Identification of the differences or gaps in the knowledge of a subject in relation to teaching across the issues determined a subject's potential for becoming a more effective teacher through the course experiences or from classroom experiences.

The implication showed it was possible 1) to identify problematic conceptual patterns of preservice teachers, 2) to define a thought-based methodology for determining directional changes in a teacher's development into a more effective teacher, and 3) to delineate the importance of the different knowledge types in relation to analyzing subjects' responses in clinical interview data.

Dedication

Dedicated to Dr. Shirley A. Brehm

and the Reverend Carol A. Spangenberg

mentor and friends who made this dissertation possible.

Acknowledgements

As the final words to this dissertation, the author wishes to express heartfelt gratitude to the many friends, family members, professional colleagues, teachers, and students who have contributed time, shared knowledge, challenged thoughts, and given words of encouragement when needed to complete the writing of the dissertation and the doctorate program of study. You, who have done so, are the silent co-authors of this dissertation. I acknowledge your contributions; intellectual challenges, emotional support, and technical assistance, as the necessary ingredients that have permitted me to author this work and begin a career as a science teacher educator.

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To my committee members, Drs. Robert Hatfield, Charles Blackman, Edward L. Smith and Charles W. Anderson, my thanks for the intellectual challenges and growth you've each provided not only in relation to this dissertation, but also through course instruction and work experience. The knowledge of teacher development, instruction, learning, and research methods you've shared were the foundations for this study and, hopefully, many future studies that will be a part of my career. You each have my utmost respect for your analytical abilities and professionalism.

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To the special friends of Carol, Cathy, Marcella, Bob, Maria, Ann and Nancy who listened frequently and supported me in the crisis times, I am especially grateful. Your encouragement will not be forgotten. May you each achieve the life dreams you have with the support and kindness you've shared with me.

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Introduction

Rationale and Problem Statement

In recent years preservice teacher education has been criticized highly for the inability to produce a consistently high quality end product: effective classroom teachers (Roth, 1985). The widespread lack of confidence in preservice teacher education has been exemplified in the plethora of teacher certification legislation revisions which have recently occurred, or are under consideration in almost every state in the nation.

These revisions are not merely updating efforts, but rather reflect dissatisfaction with programs that fail to screen and develop graduates who are effective in the classroom. Generally more stringent requirements are part of new legislation for beginning teacher certification. Examples are the passing of a competency test, or the review of teaching during initial years of service. In New Jersey intensified criticism has promoted legislation which permits the initial certification of degreed persons who lack education or pedagogical courses (Roth,1985). Such legislation clearly signals the need for a rationale for justification for the current pedagogical practices and experiences as contributing directly to the development of effective teachers.

However, it is not only those outside of the education system who are calling for accountability and justification of preservice teacher education program practices. Practicing teachers, administrators, and educational researchers are also critical of current practices. For example, classroom teacher studies, such as that conducted by Lortie (1975), have documented that teachers themselves feel that preservice eduation courses, with the possible exception of student teaching, were of little value to them in their classroom work. Most felt that they learned to teach from trial and error experiences and that foundation and methods courses were too theoretical.

In answer to criticism from teacher education graduates some preservice education programs have been modified to include more and earlier field experiences as a part of foundation and methods components. To including earlier and more field experience without documentation of the educational value of the outcomes of such experiences in relation to the development of a knowledge base for functioning as an effective teachers, is a subjective decision. This decision may have unintended and undesirable consequences for future teachers' ability to function as effective classroom teachers. The research findings of Tabachnick (1980), Hoy & Rees (1977) and the summary of research on field experiences done by Zeichner (1980) suggested that outcomes of increased utilitarian perspective, bureaucratic and custodial tendency often occured. For example, Zeichner states that as students spend more time in the field, getting the class through a lesson time in a quiet and orderly manner became the goal of instruction, rather than, achieving student learning outcomes. Such conceptions about effective teaching are in direct conflict with the desired knowledge acquisition goals of most programs. Criticism of preservice teacher education programs and practices the public and professionals issued have brought out the importance of finding answers to the questions of both, if and how preservice teacher education program practices do contribute toward the development of effective teachers.

Justification or support for education practices usually have been derived from theories or philosophical frameworks which have been substantiated by research findings about the use of a particular practice in relation to enhancement of student learning outcomes. Given the long history of preservice education in the United States, one would conjecture that at least a partial answer to the questions could be gleaned from the hundreds of research studies which have been done on preservice teacher education. Justification of preservice education practices requires such documentation to address the criticisms issued.

However, in reviewing the literature on preservice teacher education one finds little evidence to justify current practices, or that can serve as a theorectical base for program improvement modifications. Zeichner (1982) concluded his review of preservice teacher education program literature by stating that most studies have been done on a short-term time frame using a pre - post experience assessment or survey design. In attempts to control variables, studies often have had a limited focus of a particular isolated set of attitudes, or behaviors or competencies, such as questioning techniques. He concluded that research findings are inconsistent, inconclusive, and ambiguous. They have been ambiguous because researchers often failed to adequately describe the details of the experience studied to the extent that it is replicable, or can function as a model for other programs to use for making modifications.

Koehler's review (1985) of research on preservice education, done since 1980, drew similar conclusions. In addition, she pointed out the fact that there was a lack of studies investigating the more general attitudes of preservice teachers toward teaching. She noted that teaching is a complex, multifaceted activity. Actions engaged in by a teacher reflect the dynamic interactions of multiple attitudes, beliefs, and competencies, as well as the theoretical and experiential knowledge base brought to the teaching situation. A set of behaviors, competencies or attitudes studied in isolation fail to account for the dynamics of their subsequent selective, effective use by a teacher in a classroom.

Two conclusions can be drawn in relation to the present research findings available to answer the "if" and "how" questions that relate preservice teacher education experiences to the development of effective classroom teachers. First, very little is known, and hence there is a need for more studies. Second, the nature of past studies, which primarily used a humanistic, developmental, or behavioral theoretical framework for studying and explaining the human functions of teaching and learning were inadequate, and a different research approach is needed to explain the complexity of teaching and learning situations.

An alternative available to explain and study how human beings function, comes from the recently developed field of cognitive science. The methods of cognitive science, such as clinical interviews, problem-solving tasks with stimulated thought recalls, among others, provides a means of assessing and explaining complex interactions of propositional, procedural and dispositional knowledge that a teacher uses to function in situations involving teaching students, planning for instruction, or the student learning process. The unit of analysis for this research is a subject's expressed, or action implied, thoughts, as they represent the knowledge a subject has about a particular area or topic. A person's thoughts, as the unit of analysis, takes into account the interrelationship of multiple variables in complex situations that the person confronts in daily living, or in relation to tasks associated with a work environment. Thoughts are characteristics of a preservice teacher which can be documented and compared to the research findings which have documented the thought patterns of classroom teachers.

Thus, cognitive science offers not only a different theoretical framework for examining the teacher work task but also allows different questions and methods to be used to study the effects of preservice education on the development of effective classroom teachers. In addition, it also provides alternative theories for explaining how learning occurs in individuals. Cognitive science methodology and research has implications for how preservice instruction can be designed and delivered to enhance the progress of individuals toward becoming effective classroom teachers.

In the cognitive science theoretical framework, instruction is defined as a complex, multifaceted interaction process which has the intention of helping someone acquire some new capability (Resnick, 1985). In the instructional process, multiple physical, verbal and nonverbal messages are sent and perceived. Associated with these physical processes is a complex set of mental activities which enable a person to give meaning to the perceptions, and subsequently act on them to demonstrate an understanding of the message. Cognitive scientists describe this as a person using previously acquired knowledge, held in organized mental structures, or schemata to give interpretation to the situation. The <u>mental condition</u> of a student is the relationship of the mental structures or schemata associated with the topic of instruction the learner has upon entering the education experience in relation to the desired learning outcomes or the goal knowledge conceptions related to the topic of study. If instruction is successful, then new knowledge is acquired from a situation, and the individual learner has altered or changed his/her mental structures, or mental condition, as a result of the experience. Roth (1985) has done an extensive literature review w

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which relates and integrates the various cognitive science theories which have developed into a cognitive psychology instructional theory. For children learning about science, she has illustrated and defined meaningful learning as requiring instruction that directly accounts for students' prior knowledge schemata in a manner which enables the learner to fit new information into appropriate "slots" in the schemata to result in changed mental conditions which, upon subsequent use, illustrate an understanding of the real world phenomena that is congruent with a scientific explanation of the phenomena. Her study and those she reviewed suggest that meaningful learning rarely occurs simply by chance.

Teaching is a form of instruction. It is called formal instruction in such situations as a high school biology class, or a college science methods course because an adult, the teacher, is entrusted with the task of providing a collective and societally valued set of instructional experiences to a group of people. In formal instructional situations those who are to acquire new knowledge are students who are expected to individually, but simultaneously, acquire the same defined new knowledge, which is represented by the curriculum. The teacher acts as the learning process facilitator through the designing of, and the delivery of, the specific daily instructional experiences in a manner which meets the learning needs of the individual students. While the new knowledge, or goal mental structure to be learned may understandably be different for different class levels and courses, the fundamental learning process remains the same. Learning occurs when an individual

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student's mental condition is changed. Good instruction involves the accomadation of goal knowledge conceptions into mental structures or schemata by students. The mental condition of students achieves the desired state in relation to knowledge presented in instruction if instruction is successful.

In teaching, from a cognitive learning theory perspective, it is essential that educational experiences for students be designed by the teacher with the individual student's entry mental condition, and collective students' mental conditions, taken into account in relation to the goal mental structures. To successfully teach requires that a teacher have an understanding of the perceptions and interpretations that students will make of experiences provided by their instruction. Unintended learning outcomes, misconceptions, or no learning may occur from the instruction, if the individual student's mental condition starting points are not accounted for in the instructional experiences. Thus one purpose of this study was to document the concepts about teaching held by preservice secondary science teachers as they began a science methods course experience.

The goal of a methods course is to have class members learn the "how-to-do-it" of teaching a content area. The methods course instructor designs instruction by using research findings, traditional tried ways, and the established and publically desired goals for teaching a content area. The methods course instruction presented the dispositional, propositional, and procedural knowledge base associated with effective teaching as related to a particular content area. Specific dispositional knowledge, i.e. attitudes, value, beliefs, determine a specific desirable role for a teacher and for students as part of the methods course content. Propositional knowledge, i.e. facts and theories about how students learn, the nature of knowledge as content to be taught, and delivery systems for effective teaching are also addressed. Procedural knowledge uses the propositional knowledge to achieve the dispositionally defined goals, and this procedural knowledge is needed to make decisions in planning and implementing instruction.

For the instruction in the methods course to be successful, individual preservice teachers must alter their own mental condition about teaching to include the goal knowledge, or schemata which are more like those of effective teachers. The knowledge with which a student enters a course influences what is learned from the course in two specific ways according to cognitive science problem solving theory. First, prior knowledge influences what a student learns in a course by the formulation of a problem to be solved in taking the course. For example, one would conjecture that most secondary science preservice teachers register for a methods course because they want to solve the complex problem of "how do I think and act to be an effective secondary science teacher?". Such a definition of the problem, by an individual student, is desirable since the course has been designed by the instructor specifically to address this problem.

However, it is not inconceivable that methods students may define other problems. For example, some may be searching for answers to a problem related to career choice, i.e., enter with a question such as, "if I want to be a secondary science teacher what would it be like?". Others who may have worked with students before as a tutor, or in nonformal education experiences may be looking for some specific prescriptions which can be used for content delivery, or the management of students. Methods students use their prior experiences, and the resultant knowledge accumulated about teaching, to define the problem they, as individual class members, wish to solve by taking the methods course. The course's influence on changing the individual's mental condition related to teaching will only be successful to the degree that the problem defined by the individual, and those that the instructor used to design the course instruction, are compatible. A second purpose of this study was to assess what different types of problems preservice secondary science teachers defined for themselves in relation to a science methods course.

A second way in which the methods students' knowledge base is significant is in the strategy the student employs for solving his/her defined problem. How much an individual knows about the complex, multifaceted nature of teaching upon entry influences the manner in which the problem will be solved by what subproblems they may define, as well as what information an individual perceives as needed before a solution could be arrived at and acted upon. For example, one would hypothesize that preservice teachers who have had experience with children in a babysitting or nonformal education situation would ask more questions about management considerations in completion of a teacher planning task, than a preservice teacher who has had no prior experience with children. A preservice teacher who has had tutoring-type education teaching experiences hypothetically would ask more questions, or potentially seek more knowledge about student learning of content strategies, than someone without this prior experience.

What is deemed significant knowledge to acquire by a methods course student comes from the question that the individual has developed in relation to acquiring knowledge which is important for the solving of their own conceived problem and its subproblems. Thus a summative statement of the purpose of this study was to document the dispositional, propositional and procedural knowledge base about teaching that preservice secondary science teachers had as they began the methods course as it relates to the knowledge bases of an effective teacher. In other words, the consistency within the schemata related to teaching for a subject, as well as the schemata relationship to those held by an effective teacher were assessed.

The documentation of the defined problems the preservice teachers held in relation to interpreting a secondary science methods course, and the entry level dispositional, propositional, and procedural knowledge base of preservice teachers is needed for several reasons. One is that of establishing a different unit of analysis and methodology to use in assessing the influence of a methods course on preservice teachers. This is clearly needed if current criticisms of preservice teacher education programs are to be addressed by research findings. Another is to identify knowledge preservice students have at the beginning of a methods course so that more effective methods course instruction may be designed based on this information. A third purpose for this study was to assess three different data collection methods for defining the conception patterns of preservice secondary science teachers.

Questions Guiding the Study:

Two major questions guided this descriptive study of secondary science preservice teachers as they began their methods course experience. The primary and secondary questions for the study focus were as follows:

1. What thoughts or concepts about key areas associated with classroom teaching do secondary science preservice teachers have as they being a methods course?

   a. How do they perceive the teacher's role as instructional leader of the classroom?

   b. What components or frames do they address in planning for instruction?

   c. How does the meaning given to frames of planning compare to those for more effective classroom teachers?

   d. What characteristics do they ascribe to successful, or good instruction?

   e. How do the subjects' meanings for characteristics of successful instruction compare to classroom teachers' given meanings?

   f. How do they perceive the role and relationship of the students in the learning situation?

   g. By interrelating the perceptions of a preservice teacher, what overall views of teaching emerge that may be used in future long term studies, and which are suggested descriptors of how preservice teachers would actually teach if given a classroom at this time?

2. How consistent are a secondary science preservice teacher's thoughts about key areas of teaching when determined from noninstructional, instructionally related, and actual instruction problem solving tasks?
   a. How consistent are thoughts about teaching presented with the context of a clinical interview, and those inferred from actions used in planning and discussion of thought while planning a lesson for instruction?
   b. How consistent are thoughts about teaching presented in the context of a clincal interview, and those inferred from actions displayed in microteaching an inquiry science lesson with sixth grade students?

Assumptions, Limitations and Procedures for the Study:

A fundamental assumption of this study drawn from cognitive science is that thoughts are necessary precursors and determiners of a person's actions. If a preservice teacher's schemata about teaching are not reflective of an effective classroom teachers' knowledge base for decision making or problem solving, then there is little likelihood that subsequent actions of the preservice teacher will reflect those of an effective classroom teacher's. A second assumption is that secondary science preservice teachers have acquired a set of schemata related to teaching prior to beginning the science methods course.

Several limitations of the study included the time frame, the situation of the study, and the methods used. The time frame (10 weeks), did not permit the study of subjects as they would function in a normal classroom context. This limitation was addressed by using a course requirement, microteaching of an inquiry science lessons to sixth grade students, to represent the classroom functioning of subjects.

A second limitation was the time intense research procedures of descriptive research which were used for data collection. Procedures were defined to select a random, representative sample of subjects, but were not used because only fourteen students enrolled in the methods course the term in which the study was conducted. Each subject was a voluntary participant in an initial and final week of the course clinical interviews and planning recall interviews about their first and fourth microteaching lesson plans for the course. All but two students in the class participated in these interviews, resulting in a final sample size of twelve for the study. Thus, such a small number of subjects is a limitation, and findings may not be representative of all secondary science preservice teachers.

In addition, the clinical interview and planning recall interview schedules which were used contained the same questions for the initial and final interviews. This may have produced a halo effect in the data, since four interviews were conducted with each subject in a ten week time span.

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Using a clinical interview as a data source also has the inherent limitations associated with different subjects having differing abilities to articulate and honestly reveal their thoughts. To limit this inherent weakness, the ethnographic procedure of triangulation was employed, both in the structuring of the interview schedule, and in the data analyses procedures. To further exclude the researcher's personal bias in interpretation of the data, an outside coder was trained to evaluate interview and lesson transcripts.

Despite the limitations associated with this study, the findings provide a descriptive base for refining procedures and techniques for future studies. The data collection and analysis procedures defined subjects' conception patterns about teaching and defined relative scales for comparison of preservice teachers in relation to an effective secondary science teacher based on articulated thoughts about teaching and actions in teaching problem solving tasks.

Overview of Chapters

The content of Chapter I included a rationale and purpose for the study, questions to guide the study, assumptions, limitations and procedures for the study, and organization for subsequent chapters. Chapter II is a brief review of the literature related to cognitive science and learning theory, effective teaching and preservice teacher education. Chapter III presents the data collections and analysis procedures. Chapter IV is a two part presentation of the findings.

Part I is a presentation of descriptive data in an expert's description of effective secondary science teaching, and three subject case studies. Part II of Chapter IV is a summary of the findings and discussion for all twelve subjects of the study. Chapter V presents conclusions and implications of the study for further research and use in teaching preservice secondary science teachers.

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Chapter Two

Review of Related Literature

Introduction

This study was done for two purposes. The first was to document the concepts about teaching held by preservice secondary science teachers as they began a science methods course experience. The second was to assess three different types of data sources as bases for identifying the concepts or knowledge of teaching that a subject held. To accomplish these tasks the past research on preservice teacher education, cognitive science, documented characteristics of effective teachers, and theories about how one becomes a teacher were used to define the methodology, as well as the meaning of the findings and the implications of this study. Key references and findings of past research efforts related to each of these areas as they influenced this study are now presented.

Preservice Teacher Education Literature

What is known about the influence of preservice teacher education experiences in relation to the development of effective classroom teachers? Despite hundreds of studies which have focused on both specific and general outcomes of preservice education programs, two recent reviewers of this body of literature drew similar conclusions that little, if any, is known. Koehler (1985) and Zeichner (1980) conclude that past studies have failed to lend justification for current pra

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practices, or provide guidance for modifications to improve the outcomes for participants in a preservice teacher education program.

One of the major weaknesses of past studies resided in the methodology used. Behavioral, humanistic, or developmental psychological research theoretical frameworks were used with narrow foci of the studies being the isolation of behaviors, skills or attitudes of the subjects. Studies generally employed pre-post experience assessment/survey techniques that were of short term duration, and often had limited research resources (Koehler, 1985; Zeichner, 1980). Findings of these studies were inconclusive, inconsistent, and ambiguous because of inadequate experience descriptions in the reporting of findings. These reviewers of the literature and others such as Sprinthall and Theis-Sprinthall (1983) point out a need for additional studies using a different theoretical base which accounts for multiple interactions of variables associated with the complex nature of the work of an effective classroom teacher.

In addition to the limited value of past research to be able to define how experiences contribute to the participants becoming more effective teachers, some recent findings, mainly descriptive studies of student teaching, have documented miseducative learning outcomes for some preservice teachers as a result of preservice program experiences. That is, student teachers have acquired beliefs, attitudes, and practices which were directly in conflict with program objectives, or those of effective teachers (Feiman-Nemser & Buchmann, 1983; Hoy & Rees, 1977; Tabachnick, Popkewitz & Zeichner, 1980; Zeichner, 1980, 1982). For example, Tabachnick and associates found that as a result of student teaching experiences, some preservice teachers gave up the teaching goal of student learning outcomes for a goal of getting a classroom of students through a lesson in a quiet and orderly manner.

Thus, from past studies on preservice teacher education program learning experiences, two conclusions may be made. The first is that very little is known about how interrelated variables used by effective teachers are associated with the knowledge preservice teachers acquire about teaching from particular aspects of preservice teacher education program experiences. Second, is that new procedures for studying outcomes of preservice teacher education program experiences are needed. These new procedures must account for the interrelationships of the multiple variables associated with the commonplaces used by Schwab (1969) to describe the complexity of teaching. These procedures need to use something different than the behavioral, developmental or humanistic psychological theoretical framework for studying the preservice teacher's actions. An alternative is derivable from the newly emerging field of cognitive science (Koehler, 1985; Resnick, 1981, 1985; Sprinthall & Theis-Sprinthall, 1983).

Cognitive Science Literature

In the last ten years, the field of cognitive science has emerged. The underlying theories and methodology in this field provide alternative means for studying and explaining human actions or responses asso

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associated with specific life situations based on complex mental activities. The prominent theories which underly this field of study and that were used as a theoretical framework for the analysis of this study included: 1) the information processing theory (Miller 1956; Stahl, 1982), 2) problem solving (DeGroot, 1965; Lackin, et. al., 1981), and 3) conceptual change learning and instructional theory (Anderson & Smith, 1985; Driver & Erickson, 1983; Novak & Gowen, 1984; Posner, 1978, 1982; Resnick, 1981, 1985; Roth, 1985).

These theories underlying cognitive science will now be reviewed and interrelated to provide a basis for the theoretical framework used for this study. Although recent descriptive studies of classroom teachers have focused on teacher thinking and planning processes, such an integrated theoretical framework for studying preservice teacher development is noticeably absent in the preservice teacher education literature (Clark & Yinger, 1979, 1980; Koehler, 1985; Smith & Sendelbach, 1983). This dissertation study is an extension of an earlier attempt to apply a cognitive science theoretical framework to study conceptual development in preservice secondary science methods students (Slinger & Anderson, 1983). In the following paragraph, how the theories underlying the field of cognitive science influenced this study are now reviewed.

The human information process theory defined by the early works of Miller (1956) and used by Stahl (1982) to define a perceptual information processing and operations model provide explanation about

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human mental functioning capacity. The information processing theory defines the human mental capacity as having virtually a limitless ability to store information in long term memory. However, short term or working memory is severely limited to processing five, plus or minus two, chunks of information at any given time, as well as having a short time span in which to hold new sensory inputed information without either storing it in long term memory, or losing it from the knowledge base of the person.

This limited mental capacity is particularly significant in understanding how a person like a teacher process the multiple variables confronted in the complex activities and tasks of the teacher's work. Stahl's model suggests that the perception of the person and prior knowledge defines what information from one's environment is taken in, and the possible meaning or interpretation given to it in short term memory working functions. Thus, mental operations of the human being are very limited at any one time, but are facilitated by the establishment of routines, and coalescing of information into increasingly more complex theories to use in interpreting life situations. In application a teacher's knowledge of teaching becomes more sophisticated with experiences, but whether or not the teacher functions more effectively because of experiences is a factor of the variables perceived as significant and installed into the limited working memory. Thus, in this study, the definition of the problem subjects defined for course interpretation was a focus of analysis.

Other cognitivists have defined compatible theories of problem solving which elaborate Miller's (1956) work. Although many researchers have looked at specific problem solving tasks (see Resnick, 1981) to delineate specific differences in how novice and experts arrive at solutions, Shulman and Elstein (1975) present a theoretical perspective to the problem solving process which elaborates on how a person handles multiple variables in relation to the limited working memory capacity effectively.

Shulman and Elstein (1975) worked first with physician diagnosing procedures, and later with teacher decision making. They defined a person's actions taken in a situation as the end result of problem solving mental operations. They stated that a person defined his/her own unique problem in relation to a situation based on prior related, relevant stored knowledge about similar situations. Once the personal problem is defined, then phase one of decision making occurs, in which relevant and select information that is known is brought to bear in specific known strategies to define a set of alternative viable solutions. A second mental phase of problem solving, judgement making, is then done with the alternative solutions to determine what the best solution or response to the situation would be, and that is the behavioral response of the individual to the situation.

Little is known about the specific knowledge teachers have and use in relation to the specific details of the mental actions they use in their work situations. Some teachers are more effective in producing student learning outcomes than others. Some behaviors, attitudes and skills are correlated with student learning outcomes in situations. What is known is that some teachers consistently are more effective teachers, and others are consistently less effective. What this study addresses is to begin to document the knowledge of preservice or novice teachers in relation to that of effective teachers.

This comparison of preservice teachers' knowledge about teaching with that of effective teachers is rooted in the literature which has documented that experts and novices solve problems using different strategies and information to arrive at solutions or actions. For example, DeGroot (1965) in studying chess players found that the sequence as well as the variables brought to bear on the problem defined by a person were different for the expert than those used by a novice player. Not only the length of time required for a novice to solve a problem, but also the knowledge held about strategies for solving a problem, and the relevant variables the problem solver used were of significance. Others as summarized by Resnick (1981) have found that in less structured task completion situations, the novice and expert often define different problems for solving, in addition to using different problem solving strategies and variables of influences in relation to arrived at solutions (Anderson & Smith, 1985; Larkin, et. al., 1981; Resnick, 1985).

The importance of these theories in this study was the composite view and conclusions which can be drawn if teaching is viewed as a complex activity of human problem solving, and learning is viewed as a problem solving situation. If a human's actions are the result of complex mental activities which are initiated by situations of life, then in teaching continuous problem solving mental operations occur and the underlying knowledge base including theoretical knowledge, procedural or problem solving strategy knowledge, and dispositional or value and attitude related knowledge are of importance with respect to defining personal situation specific problems as well as the decision-making and judgement making mental operations of solving the problem. The knowledge base and the knowledge application used are hypothetically different for the preservice teacher, less effective teacher and that of the experienced expert or effective teacher. Documentation of this knowledge base difference would be a base for studying the influences of preservice teacher education experiences in relation to developing effective teachers. It would lend justification to preservice education if mental operations and knowledge base differences were found to change in a direction which more closely reflects the knowledge base of teaching held by an effective teacher.

The significance of these theories, however, cannot be limited to just the context of teaching actions as being effective. Rather, the goal of preservice teacher education is to result in students, preservice teachers, undergoing the learning process to become effective teachers. The cognitive science theories of conceptual change learning and instructional design lend additional support to the need to define concepts or knowledge about teaching held by preservice teachers. Roth

(1985) has done a comprehensive review of the literature related to the development of these theories. The implications in relation to this study lie in how the knowledge brought to a course by students, discussed as naive or misconception theories, influences the students' interpretation of an instruction experience, and renders the experience as educative or miseducative in relation to desired learning outcomes defined by the teacher. Instruction must be designed in a way which accounts for students' entering conceptions about a topic, directly confront inappropriate knowledge the student may hold, and provide practice for the situation to be an integrated meaningful learning experience (Roth, 1985). In relation to Roth's work, an assumption of this study is that the knowledge base of teaching is similar to any other discipline knowledge base such as researchers have found in science topics. Each has unique dispositional, propositional and procedural knowledge which is defined as desirable for the student to acquire from instruction. Effective teaching accounts for this in design of educational experiences.

In conclusion, the theories of cognitive science have not been derived by studying isolated behaviors, skills, competencies or attitudes of a person. Rather, a task or situation is studied with complex mental operations documented. Specific methods used have included the use of clinical interviews, video and audio recording of task completion procedures, pre- and post-testing, and task completion with thought recall, or thinking out loud, interview procedures (DeGroot, 1965; Smith & Sendelbach, 1982). This study was designed to test these techniques to assess the knowledge about teaching held by subjects, and made more or less available for analysis from clinical interviews, a lesson planning task with thought recall, and a taped microteaching lesson done with an inquiry science lesson taught to sixth graders. In recent years, such techniques have been applied in educational studies of classroom teachers, generally as a part of descriptive studies.

These techniques have identified some differences between more or less effective classroom teachers. However, the use of such techniques to study changes or differences in preservice teachers have rarely occurred (Tabachnick, Popkewitz & Zeichner, 1980). These techniques present an alternative approach for assessing preservice teachers in a manner which can relate their held concepts to those of more effective practicing classroom teachers. These alternative methods that use a person's thoughts or concepts as a unit of analysis provided the basis for this descriptive study of concepts about teaching held by preservice secondary science teachers as they began their secondary science methods course.

Studies of the Characteristics of Effective Classroom Teachers

If the goal of preservice teacher education is the development of effective classroom teachers, then what is known about effective teachers should become fundamental criteria for assessing changes in preservice teachers. Although this seems sensible and logical, most past studies of preservice teacher education have referred to specific goals or statements of purpose in relation to the desired learning outcomes for preservice teachers, but there have been few attempts to directly connect these outcomes with effective classroom practices or teacher characteristics (Feiman-Nemser, 1983; Floden & Feiman, 1980)

Findings in recent years, from descriptive studies of classroom teachers have delineated some characteristics of good teachers (Brophy, 1978; Brophy & Putnam, 1978), more effective managers (Anderson, Evertson & Emmer, 1981), teachers as decision makers (Clark & Yinger, 1979), and teachers as planners (Clark & Yinger, 1980; Mc Cutchion, 1981; Smith & Sendelbach, 1982). While these described characteristics and skills of effective teachers do not encompass the whole of the teacher's task environment and role, they do provide a basis for discerning differences among teachers.

From classroom studies the described skills, competencies, attitudes, values and theoretical knowledge of more effective teachers are complex, multifaceted and integrated in use in particular ways that result in effective actions. The secondary science teacher is no exception. The National Science Teachers Association's position statement (1982, 1983) defines an effective teacher as one who addresses and teaches the dispositional, propositional and procedural knowledge base of science. An effective teacher is a teacher whose learning outcome goals include science process skills, major concepts of science, applications of the concepts, and also addresses related societal issues. Implicit in this national association's position statement are the underlying theories that 1) all students are capable of learning and acquiring knowledge in order to be scientifically literate citizens, 2) a high percentage of classroom teaching time must be used to engage students mentally and physically in a variety of science learning activities for a high level of learning outcomes to occur, 3) prerequisite knowledge is significant in relation to learning science and therefore must be accounted for in design and implementation of instruction, and 4) multiple modes of teaching enhance student outcomes by addressing individuals' as well as groups of students' varied learning needs (Collete & Chiappeta, 1984; Farmer & Farwell, 1983). These theories about effective science teaching are supported by the numerous recent conceptual change studies of learning science. Anderson and Smith (1985) present a comprehensive summary of this literature as it relates to effective science teaching. The effective science teacher is defined as a conceptual change teacher: someone who effectively and efficiently designs and implements insturctional experiences which account for students' mental condition in relation to desired learning outcomes. This is accomplished through such techniques as preassessment, active mental engagement of students in learning, and direct confrontation of inappropriate student knowledge through a variety of instructional experiences designed to induce changes in students' knowledge structures.

From classroom studies we know that the described skills and characteristics of more effective teachers are complex, multifaceted, and difficult to acquire. They cannot simply be taught or told to preservice teachers. These same characteristics are often the described goals and desired learning outcomes for preservice teacher education programs. As such, characteristics of effective classroom teachers should provide guidance for assessing the directional developmental changes in preservice teachers in a preservice education program.

This study used descriptions of effective teacher characteristics as a base for analysis of concepts held by secondary science preservice teachers (subjects) about teaching, planning for instruction, instructing, and nature of students as learners. The responses of subjects to interview questions and teaching tasks were used to infer conception patterns about: the nature of the teacher's work; a problem for interpreting the course; determiners of the curriculum; and idealized and realistic views of teaching which represented a subjects dispositional, propositional and procedural knowledge base of teaching.

Theories about Becoming a Teacher

Becoming a teacher is a stressful process in which preservice education has often been viewed as merely a required "rite of passage" by many classroom teachers in retrospection (Lortie, 1975; Feiman-Nemser, 1983; Fuller & Bown, 1969, 1975). Several different theories exist about how one becomes a teacher. Lortie (1975) has presented a socialization model, while Fuller and associates (1975) have proposed a stages of concern model, and Feiman-Nemser (1983) presents a cognitive development based model. Although the specific nature and implications for preservice teacher training vary with each model, they do appear to agree on the desired end results. Each concurs that the effective, or professional teacher functions out of a concern for student learning. The goal of preservice teacher education based on these theories is to develop practices and fundamental propositional, dispositional, and procedural knowledge which enables a program's graduates to act with a concern for student learning. Program graduates must be able to link theory and practice to function as effective classroom teachers (Zeichner, 1982; Koehler, 1985).

However, as cautioned by Feiman-Nemser (1983) this may not be possible to achieve in the limited and constrained time of most preservice teacher education programs. She stressed that at least the foundations for developing into effective teachers should be the learning outcomes for students of a preservice education program. She further cautions that there is a difference between the thoughts of a person and the ability to act according to those thoughts. Yet, if a preservice teacher's articulated thoughts or concepts about aspects of the teaching task environment do not reflect ideas similar to those of more effective classroom teacher's it is highly improbable that future classroom experiences will be interpreted in a manner which changes their held conceptions and ways of acting (Posner, 1978). During preservice education the entering mental conditions of students in relation to effective teaching, which have been established by hundreds of hours of experience as a student, must be examined and modified to change the individual preservice teacher from a layman's perspective to that of the professional teacher, if effective teachers are to be the end product of preservice teacher education (Feiman-Nemser, 1983; Lortie,1975).

In the present study thoughts, although they are not direct definers of a person's actions, are accepted as representations of a range of probable behaviors a preservice teacher would exhibit. The articulated concepts about specific aspects of teaching serve as the basic components for defining conception patterns which depict the knowledge base of a subject. Each particular component represents an interrelationship of knowledge. The interrelationships of concepts held by each study subject as they were related to effective classroom teaching also served to provide a composite view of how a preservice teacher would function in a classroom setting, and how they could learn from experience in the future. In this study conception patterns for five issues related to functioning or learning to function as an effective classroom teacher were studied for twelve preservice secondary science teachers as they began a methods course experience. Teaching styles, descriptors indicative of the dispositional, propositional and procedural knowledge base were developed to characterize patterns of thoughts subjects have at this point in their professional education to be teachers.

Furthermore, just as an artist's final "masterpiece" presents a central focus of attention to the viewer, teaching styles of these preservice teachers also defined their central focus of concern for functioning in a classroom. Like the novice artist's end product, the focus of attention in a completed picture is often not that intended by the artist in the creation process, or this focus many times is less clearly visible than that of an expert. The preservice teachers' dispositional knowledge base may define a picture of teaching which closely resembles that of an expert, but they may not have the propositional and procedural knowledge about teaching which would allow them to implement their ideals. The idealized teaching descriptors present differing central foci for their potential actions which may be compared to those of an effective teacher. They provide a means of assessing to what degree each preservice teacher would function as an effective teacher who has student learning as his/her central focus. Thus, the creation of this composite view of each preservice teacher serves as a means of providing initial documention for further studies of how preservice education program course experiences may result in directional changes in preservice teachers in relation to becoming effective classroom teachers.

This study provides an understanding of the knowledge base for teaching that preservice teachers have upon entry to a science methods course and assesses two course assignments as a means of data collection about concepts and conceptual patterns about teaching. It defines an approach to methods of assessing preservice teachers which accounts for the complex nature of the work and provides a base for comparison with the functioning of effective classroom teachers.

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Chapter III

Methods and Procedures

Introduction

The purposes of this study were to document concepts about teaching held by secondary science preservice teachers as they began a methods course, and to assess three different data sources as bases for identifying subjects' concepts. The study was guided by the following two major questions and associated subquestions developed out of the theoretical framework Schwab (1969) defined for teaching. He defined the commonplaces of teaching as students, curriculum, teacher and milieu.

1. What thoughts or concepts about key areas associated with classroom teaching do secondary science preservice teachers have as they begin a methods course?

    a. How do they perceive the teacher's role as instructional leader of the classroom?
    b. What components or frames do they address in planning for instruction?
    c. How does the meaning given to frames of planning compare to those for more effective classroom teachers?
    d. What characteristics do they ascribe to successful, or good instruction?
    e. How do the meanings given to characteristics of successful instruction compare to those of a effective classroom teacher?
    f. How do they perceive the role of students in the learning situation?
    g. By interrelating the perceptions of a preservice teacher, what overall views of teaching emerge that may be used in future long term studies, and which are suggested descriptors of how preservice teachers would actually teach if given a classroom at this time?

2. How consistent are a secondary science preservice teacher's thoughts about key areas of teaching when determined from noninstructional, instructionally related, and actual instruction problem solving tasks?

    a. How consistent are thoughts about teaching presented within the context of a clinical interview, and with those inferred from actions used in planning and discussion of thought while planning a lesson for instruction?
    b. How consistent are thoughts about teaching presented in the context of a clincal interview, and those inferred from actions displayed in microteaching an inquiry science lesson with sixth grade students?

To accomplish these tasks, the descriptive and cognitive science research data collection techniques of clinical interviews, planning recall sessions, and nonparticipant observations were used to study a class of students in a secondary science methods course (Schatzman & Strauss, 1973). In this chapter the study context, the subjects, data collection methods and analysis procedures will be described.

Description of the Study Context

The design of this study was based on an earlier study describing the influences a secondary science methods course with a microteaching experience had on preservice teachers' development (Slinger & Anderson, 1983). Different concepts about teaching held by preservice teachers were identified in the study by using pre- and post-course clinical interviews. A subject's identified concepts about teaching were used to define a potential teaching style for the subject. The earlier study, however, was limited and did not adequately identify means of defining teaching style which reflected the different types of knowledge bases about teaching subjects had and used in problem solving, or decision making as a teacher. It did provide a base for reformulating interview questions used in this study and defined the need to more thoroughly assess and describe conceptions of teaching preservice teachers have as they related to the knowledge subjects brought to the methods course situation.

Therefore, this study was an extension of this earlier work. It used a refined set of questions in the clinical interview and two specific course experiences, the planning of a lesson and microteaching of the lesson as additional data sources for inferring concepts and defining the knowledge base of teaching subjects had as they began the methods course.

Population of the Study

The entire class (n=14) of preservice secondary science teachers enrolled for the secondary science methods course (Fall, 1983) at a land grant university, volunteered to paticipate in this study. Two subjects were eliminated from the sample, however, due to incomplete data sets which resulted from the subjects' repeated failure to be present for interviews scheduled at their convenience. Thus, the population for this study was twelve preservice secondary science teachers who were enrolled for the same science methods class. The twelve subjects were four females and eight males with secondary science majors in biology (6), earth science (2), general science (2), physical science (1), and math with a physical science minor (1). Three of the male subjects were older students who had considerable work experience (> 5 years) in other occupations. Two other males were extending their studies, past bachelors, to attain teacher certification. The other three males and one female subject were completing bachelor degrees requirements in a five year time span. Only the remaining three female subjects of this group were completing degree and certification requirements in a traditional time frame of a four-year program. When they began the course, seven of the twelve believed they would pursue an alternative career to secondary science classrooom teaching. Nine believed they would teach for awhile and then pursue their alternatives.

This group of subjects was similar to the population of the earlier study in which the population also was composed of students in a secondary science methods course taught by the same instructor at the same institution. However, in comparison to the population of the earlier study, these students did not readily respond to the course instructor or instruction format. The professor periodically expressed frustration over this, and was uncertain about the group's unwillingness to participate in discussions or respond to instructor questions during lecture. They were, however, responsive and responsible in completion of assignments and enthused about the microteaching component of the course. Their responses to tests, assignments, and the microteaching experience were similar to those of the subjects of the earlier study.

Data Collection Procedures

To accomplish the two purposes of this study, the data collection focused on three different situations related to functioning as a teacher. Data which focused on how a subject talked about functioning as a teacher was collected by using a clinical interview. Data which addressed functioning as a teacher in a noninstructional task came from a lesson plan assignment and planning recall interview. Data which documented the subject functioning as a teacher came from a microteaching course experience. The collection procedures used for each are described below. In addition to these primary data sets, all course instruction was audio recorded and field notes were taken by a nonparticipant observer in each class session. The course instructor was also interviewed using the subjects' clinical interview schedule to define the responses of an expert, the effective teacher, as a comparison base with subjects.

The Clinical Interview Data Set: Entry to the course concepts about major aspects of teaching and teaching tasks for each subject were assessed by conducting and audio recording two clinical interviews. Interviews were conducted during the first and last week of the ten week course.

Standard descriptive research interviewing techniques were used (Gordon, 1980). The initial and final interview question and probe schedules were identical with the exception that background information was collected as part of the initial interview, and all predictive questions, such as, "What do you want to learn from the course?", were changed to past tense questions in the post course interview (See Appendix A). In general, open-ended questions for each set of questions based on Schwab's (1969) commonplaces of teaching were asked first with task specific questions following. Probes to clarify response meanings were used when necessary with subjects. All subjects were interviewed by the same interviewer in the same setting.

The clinical interview data set for analysis consisted of transcripts of the audio-recorded initial and final interviews. The initial interview transcript was the primary data source for entry to course concept determination. The final interview was used only as supportive evidence in relation to entry concepts.

Plan and Recall Data Set: Each subject was interviewed within three days prior to the microteaching of a lesson plan s/he formulated as a course assignment. These interviews occurred in relation to the first and last of four microteaching lesson plan assignments during the first and ninth weeks of the course. Procedures used were based on those described by Smith and Sendelbach (1982). The schedule of questions used in the plan recall interview is presented in Appendix A.

Instructions given to subjects in relation to formulating the plan were simply the topic area of the lesson, a reference and library location for the teacher's guide, a description of the small rooms used for microteaching, and methods for working as pairs for teaching an hour lesson to small groups of local sixth grade students brought to campus for the microteaching lessons. The assigned topics for teaching were the Batteries and Bulbs, and Whirly Bird units from the Elementary Science Study and Science Curriculum Improvement Study curriculum projects respectively.

To assess each subject's planning process, the propositional and procedural knowledge about teaching, subjects were asked in the interview to recall and describe the procedures they used to formulate their written lesson plan. After a subject described his/her procedures, s/he was asked to describe in detail what was thought about before the plan was written, and then how s/he envisioned the lesson would be implemented, and how s/he would know if it was successful. Open-ended questions, followed by probes for meaning, were used throughout the brief (fifteen to thirty minute) planning recall interview. Subjects were provided with a teacher's guide and were asked to bring a copy of their plan with them to use during the interview.

The Plan and Recall Data Set for analysis consisted of the written lesson plans for each lesson and transcripts of each interview. In addition, if the subject made notes prior to writing their plan, these were copied and added to the data set. In this study, only the plan and recall related to the first microteaching lesson on batteries and bulbs was analyzed for subject's entry to course concepts about teaching.

Microteaching Lesson Data Set: Each subject taught four twenty-five minute inquiry science lessons to small groups (n=3/4) of sixth grade students as a part of the methods course. The sixth grade students brought to campus for this experience were from an inner city school with a very diverse population, including non-English fluent students. Students were randomly assigned to paired subject teaching teams.

A microteaching lesson session consisted of two twenty-five minute topic related lessons. First, one subject teaching team member would present his/her lesson while the other subject team member was a nonparticipant observer of the lesson. Then, the students were given a brief break, and the teacher team subjects reversed roles. How lessons in a session were related was a factor decided by the subjects of each teaching team. Typically teams met and discussed division of the topic, and then independently formulated his/her own lesson plan.

The nonparticipant observer role for a team subject involved using a semi-structured classroom observation instrument which was explained to all subjects prior to use. The observation guide required the assessment of classroom teacher and student behaviors and activities every five minutes of the lesson with general notes taken in between (See Appendix A). Following the lesson, summary narratives and critiques were written by team partners as a part of the methods course assignments. These subjects' critiques and field notes were a part of the microlesson data set.

In addition to data provided by audio recording of the lesson and subjects' observation notes and critiques, outside trained observers also observed lessons and completed a brief summary of teaching survey for subjects. These observers were instructed specifically to note teacher and student interactive behaviors. The outside observer's field notes, transcript of the lessons, and subject team observation notes and critique, constituted the microlesson data set for analysis.

Class Instruction and Course Instructor Interview: All class instruction for the methods course was audio-recorded with field notes taken by a nonparticipant observer. These were used as a means of understanding the influences of the class referred to by subjects in final interviews, and to define the goal conceptions for effective teaching presented in the course. To further understand and define the goal concepts about effective teaching, the course instructor was interviewed using the same question schedule as used with the subjects in the initial clinical interview. These data were used to define the goal conceptions of an effective secondary science teacher which were presented in this study as an expert's description and views of effective teaching in Chapter IV, Part I.

In summary, data was collected in multiple ways at different times in the course to answer the two purposes of this study. Figure 3.1 presents a concise view of data collection procedures and the time line used for this study of a ten week term science methods course.

Data Analysis

Preliminary Data Analysis Procedures

As a descriptive study the techniques of ethnographic research were used for the process of data reduction and triangulation for validity of finding. In data reduction, key issues for a foci for the analysis in relation to the two purposes of this study were sought from the rich

Figure 3.1

Data Sources, Collection Procedures and Time Line for the Study

Data Set (+abbreviations)	Procedures for Collection	Time in Course Primary Data (Secondary Data)
Clinical Interview (I. I.) (F. I.)	One hour recorded interview with open-ended Questions with Probes, Application teaching task, and Application planning tasks	1st Week (10th Week)
Plan and Recall (I.P.R.) (F.P.R.)	Fifteen to thirty minutes recorded interview with open-ended focused questions about a written inquiry science lesson plan (microlesson plan).	2nd Week (9th Week)
Microteaching Lesson (I.M.L.) (F.M.L.)	Transcript of twenty-five minute lesson, field notes & critiques of lesson by peer subject and outside observer	2nd Week (9th Week)
Course Instruction and (F.N.)	Nonparticipant observer field notes	1st through 10th week of course
Instructor Interview (I.C.)	One hour recorded interview identical to subjects' clinical interview	5th week of course

data sets (Schatzman & Strauss, 1973; Wax, 1971). Initial readings of all data sets resulted in so many different concepts about teaching being identified for the subjects across the data sets that a means of coalescing the data into a meaningful discriminating system of conceptual patterns was necessary.

Initally the four commonplaces of teaching theoretical framework related to the questions of the interview and categories related to the earlier study were used to define central issues upon which subjects differed significantly in an interrelated manner in relation to effective teaching, or learning to become an effective teacher. However, only one key issue was identified based on Schwab's (1969) framework for explaining teaching. This was the description of the nature of a teacher's work as a simple or complex task. It differentiated the study subjects consistently across data sets.

However, this commonplace theoretical framework failed to discern futher conception patterns in an interrelated meaningful way which defined the subject's potential and current status in relation to functioning as an effective teacher. Thus, a reanalysis of the concepts found for subjects and goals of the professor for the course resulted in the adoption of a cognitive science theoretical framework for analysis. This framework coalesced subjects' concepts into several central issues which then were used to discriminate subjects and define their current status in relation to being effective teachers as well as their current potential for learning from course experiences designed to develop subjects into effective teachers.

Applying the cognitive science problem solving and learning theoretical frameworks to the concepts about teaching held by subjects resulted in discriminating subjects relative to the key issues of: 1) problem for interpretation of the methods course instruction, 2) views for teaching students science and, 3) methods for defining the curriculum for a course. Clinical interview responses provided consistent responses in relation to the problem for course interpretation and methods for defining a course, but were problematic for the views of teaching.

The views of teaching issue proved to be problematic in analysis, because discrepancies were found within a subject's clinical interview data set responses across concepts about the teacher's role and student's role. These seemingly conflicting concepts for defined teacher's role or student's role in instruction resulted in reassessment of the original data with a distinct reason for the differences identified, as being related to the type of knowledge a question required the subject to use in responding.

Interview questions, which were very specifically designed situations involving application of knowledge to a teaching task, resulted in a different pattern of concepts about teaching than those found in responses which addressed values, beliefs or attitudes about teaching. These seemingly discrepant conceptual patterns were not discrepant in the clinical interview data when a decision-making and judgment theoretical framework was applied (Shulman & Elstein, 1975).

In brief, judgments are defined as arising out of a person's dispositional knowledge base or their beliefs, attitudes and values, while decision making involves the propositional and procedural knowledge base. A person's actions in relation to a situation are the result of both decision making and judgment processes. Shulman & Elstein (1975) described the process of decision making as being the initial step of the individual in a situation defining a personal problem for solving related to the situation. This problem of the individual is uniquely defined based on the related propositional and procedural knowledge accumulated in mental structures. Once the problem is defined the person again brings to bear appropriate propositional knowledge using his/her procedural knowledge to arrive at some alternative solutions, which are exemplified in behavioral action responses to a situation. A person generally can define more than one possible way of acting in relation to a situation, and hence, makes a choice among the alternative actions before acting. This choosing of an action to take is the judgmental aspect of problem solving which occurs after the mental decision-making process is completed and alternatives are defined out of the individual's propositional and procedural knowledge base. It is the dispositional knowledge base which is used for judging and determining what action will be taken by the person in response to a situation.

Hence, in relation to the issues of this study, interview questions which addressed dispositional, propositional or procedural knowledge were isolated and concepts about teaching reclassified on this basis for analysis. The propositional knowledge base was defined as most evident in application situations involving the teacher's task of instructing students, while the procedural knowledge base was defined as addressed by planning teaching tasks. The dispositional knowledge base was defined by responses to interview questions about ideal teaching situations.

The propositional and procedural knowledge bases were available for analysis across all data sets, while the dispositional knowledge base about teaching was limited to the clinical interview data set for final analysis procedures.

In summary, for final data analysis procedures, not all data sources provided evidence of subject's concepts in relation to all key issues which emerged from subject's concepts about teaching. Figure 3.2 presents the data sources used to address each key issue of this study.

Figure 3.2 Study Issues and Data Sources for Defining Subjects' Conceptual Patterns about Teaching

Study Key Issue	Data Source for Defining Subject's Conceptual Pattern	Emphasis of Questions or Tasks Responses Analyzed
1) Nature of a Teacher's Work	Initial Clinical Interview	How prepared to teach? Rationale for teaching career.
	Final Clinical Interview	Commitment to teaching change.
2) Course Problem for Interpretation	Initial Clinical Interview	How not prepared to teach Concerns in relation to Microteaching.
	Final Clinical Interview	What learned from course
3) Idealized Teaching View (dispositional knowledge base for teaching)	Initial Clinical Interview	Most important role of a teacher. Judging another teacher's teaching successfulness. How to use time in teaching. Problems anticipate students have in learning science and what would do as a teacher.
4) Realistic View of Teaching (Propositional and procedural knowledge base for teaching)	Initial Clinical Interview	Own teaching successfulness situation Procedures Daily Planning
	Plan and Recall Interview	Envisionment of planned lesson implementation Thoughts & procedures in formulating written lesson plan for Microlesson
	Microteaching Lesson	* Elements of lesson used in instruction # Planning frames inferred from problems & decisions identified in instruction
5) Determinants of the Curriculum	Initial Clinical Interview	Long Range Planning

* The set of essential elements used for analysis were: lesson set, new content presentation, practice with feedback, summary and extension activity (Good & Brophy, 1984).

Planning frames/components used for analysis were: learning outcomes, objectives, assessment, teaching strategy, activities, sequence of content, management of materials, management of student behavior, and time (Slinger & Anderson, 1983: Smith & Sendelbach, 1982).

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Final Analysis Procedures

<u>Procedures for Final Analysis</u>: Each subject's data set was reanalyzed to define conceptual patterns for each issue. Schwab's commonplaces were used to define ranges of subjects' responses in relation to the first issue, while specific discriminating descriptors had to be defined for all other issues based on the responses of subjects found in the data.

The defining of discriminating descriptors for each issue was accomplished by selecting three representative subjects of the class in relation to major, commitment to teaching, and representive responses to interview questions about the teacher's role and planning procedure for intensive analysis. These subjects identified conception patterns and those the course instructor expressed in the interview and class instruction, defined the set of descriptive discriminators in a manner which presented a relationship of a preservice teacher's thoughts and those of an effective teacher. These identified issue-related sets of discriminators were then used for analyzing all other subjects data sets to answer the two original purposes of this study; identifying concepts of subjects and effectiveness of data sources for inferring subjects' concepts.

The set of discriminating descriptors for each issue and their meanings are defined in detail by the use of case studies in the presentation of the findings and description of effective teaching of the expert (Part I of Chapter IV). They are also presented in the findings and the reader is referred to Chapter IV, Part II for a complete description and definition of defined issue discriminators.

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Chapter 4

Presentation of Data and Discussion of Findings

Introduction

This study had two major purposes. The first was to document concepts about the various aspects of teaching that preservice secondary science teachers (subjects) had as they began a secondary science methods course. The second was to assess three different data sources as a base for information about the concepts held by the subjects.

The first purpose, to identify the concepts held by subjects, was answered by clinical interviews which were conducted with each (n=12) member of a secondary science methods class during the first and final week of the ten week course. The theoretical framework used to define interview questions and probes were the four commonplaces of teaching defined by Schwab (1969). The subjects were asked questions and probed to elucidate their understanding about students, teacher, curriculum and milieu. The articulated responses presented a rich data source containing multiple dimensions and aspects associated with each commonplace which then could be used to define held concepts for comparison both within the set of subjects and with those of effective classroom secondary science teachers (effective teachers).

However, it was considered beyond this dissertation to address all the concepts articulated about teaching by the study subjects. Hence, alternative theoretical frameworks were used for data analysis which would coalese the held concepts about students, teacher, curriculum and milieu into representative descriptive conceptual patterns. Such patterns were defined in a manner which would facilitate the comparing and contrasting of the findings to answer the first purpose of the study. The conceptual patterns determined from articulated thoughts in the clinical interview were also the basis for comparison of those found for each subject in the two other data sources used in this study to answer the second purpose. The two other data sources for inferring concept patterns were the lesson plan with a recall interview transcript for the first inquiry microteaching lesson experiences of the course (plan & recall), and the transcript and field notes made of this planned lesson as it was taught by the subject to small groups of sixth grade students.

The first conceptual pattern set which emerged from the data was that not all subjects were consistent in their expectations for the course. Based on the conceptual learning theory framework the group of concepts related to course expectations held by subjects were coalesced into a pattern which is represented in these findings as the key issue of a problem each subject defined for interpretation of the course.

A second major difference among subjects was that of their expressed knowledge about the skills of teaching. These were very discrepant across articulated responses. However, these discrepancies generally occurred between answers to open-ended questions about teaching and specific questions which required the application of knowledge about teaching in a given hypothetical teaching task situation. For example, in response to the most important role of the teacher, an individual subject may state and believe that it is important to motivate students to learn, but fail to consider, or address this in any manner in a response to planning for daily instruction. To explain such occurences in the responses, a multiple knowledge base theoretical framework was used. The dispositional, propositional, and procedural knowledge bases for teaching were implemented to coalesce concepts into two views of teaching for each subject. The dispositional knowledge base, i.e. the beliefs, attitudes and values articulated by the subject about the role of the teacher and role of the student in science instruction, was used to define an idealized view of teaching for each subject. A realistic view of teaching was defined by concepts about teaching patterns expressed in application type situational responses which required the use of a subject's propositional and procedural knowledge base about teaching.

Application situations representing the teacher tasks of planning and implementing instruction were used within the clinical interview. Responses associated with an actual teaching description situation were considered as representative of the propositional knowledge base of the subject. The planning task situations were considered as representative of the procedural knowledge base of teaching.

The assessment of the propositional knowledge base about teaching employed the theoretical framework of the key components of a lesson and their meaning to the subject. In the findings they were presented as the essential elements of a lesson conceptual pattern. They were used as descriptors of a subject's propositional knowledge and used as a base for defining roles for the teacher and for students. These defined role descriptions provided a comparison base across the three data sources as a means of evaluating the fruitfulness of each in revealing the propositional knowledge about teaching of subjects.

The teaching procedural knowledge base was assessed by using the daily lesson plan components or frames as the foundation for the theoretical framework. The decisions a teacher makes in relation to different frames is a means of establishing a mental set for teaching. These planning frames, and the meanings given to them by a subject, defined a descriptive role for the teacher and a particular role for students which was used as a comparison base within a subject's knowledge about teaching, across subjects, and across data sources to address the second purpose of this study.

In addition to defining a problem for course interpretation and specific conceptual patterns related to knowledge bases for teaching, data in the clinical interviews yielded one final pattern of concepts about teaching related to long range planning for instruction. The framework used to define the pattern was a view that planning is a two phase process, first acquiring a knowledge base for use in the second phase, which involved defining what will be done in the classroom (Slinger, Smith, & Anderson, 1982). The specific types of knowledge a subject deemed as necessary for the long range planning task of teaching is presented in the findings as the determinants of curriculum.

The format which was used in this chapter to present the data and to discuss the findings was as follows: first, data was presented in descriptive case studies to provide a detailed description of the knowledge about teaching held by an expert and the subjects of this study. Secondly, this description was then summarized in a contrast and comparison discussion for the case study subjects as a foundation for presenting and explaining the findings of all subjects in relation to both purposes of this study.

The presentation of data began with a descriptive accounting for teaching by an expert, the course instructor. This served as a vehicle for representing the goal conceptions about teaching held by effective secondary science teachers and the desired learning outcomes for the methods course subjects of this study. It was formulated from the instructor's responses to the same clinical interview questions as were used with the subjects and supplemented by field notes taken daily on the methods course instruction. It defined a base for comparison of the conceptual patterns of an effective teacher with those of the preservice subjects. The expert's description of teaching was followed by three representative case studies of the subjects. These present examples of the language used to express concepts held and the range of conceptual patterns found among the twelve subjects of this study. The expert's description of an effective teacher and the case studies were developed with a specific organizational format in order that data addressing both purposes of this study were presented. Each case study begins with two issues, which addressed the general knowledge about teaching orientation a subject held. This was presented in the background of the subject, the nature of a teacher's work, and problem for course interpretation.

This general knowledge held by a subject was then assessed in more detail by analyzing specific dispositional, propositional and procedural knowledge about teaching conceptual patterns for a subject. This specific knowledge was presented as a subject idealized and realistic view of teaching.

The idealized view of teaching was the third section in each case study. Dispositional knowledge was only addressed by subjects in the data collected by clinical interviews. Therefore, within the idealized teaching section of each case study, a subject's beliefs about successful instruction were used as an introduction to subsections which present the subject's beliefs about first, the role of the teacher, and then the role for students in instruction. These conceptual patterns, coalesced into specific descriptive labels for the teacher and students, were then summarized by the concluding idealized picture of teaching.

The fourth section of the case study, the realistic view of teaching, presents the specific propositional and procedural knowledge base about teaching conceptual patterns held by a subject. Since information about these knowledge bases was collected from subjects in three different ways (clinical interview, lesson plan and recall interview, and microteaching lesson) each data source knowledge is presented to address the second purpose of the study, as well as the first of defining a subject's concepts about teaching.

A specific format was used within the realistic view of teaching to facilitate addressing both purposes of the study. For each data source, two application of knowledge situations were presented. The subsection for a data source began with assessment of a teaching situation. This was presented as the essential elements of a lesson. The descriptors of lesson elements for effective teaching presented by Rosenshine (1984) and Good & Brophy (1983) were the base of an analysis for presenting the conceptual pattern of a subject. The essential elements and meaning were used to define roles for the teacher and for students for use in comparison of data sources and concepts about teaching propositional knowledge of a subject.

The procedural knowledge about teaching as conceptual patterns of a subject are the second subsection presented for each data source. The conceptual patterns were analyzed and presented as the essential frames for planning. They were based on the frames or components a subject made decisions about in the process of planning a daily lesson (Slinger & Anderson, 1983; Smith & Sendelbach, 1982). Again, the frames addressed and the meaning given to them by the subject defined descriptive roles for the teacher and for students which were used for comparisons across data sources as well as for defining concepts about teaching held by a subject as s/he began the methods course.

The realistic view of teaching issue was summarized for a subject following the presentation of conceptual patterns found independently for each subject's three data sources. This was presented as the realistic picture of teaching conclusion to each case study's fourth section. It presented a composite view of how the subject would potentially function in the classroom based on held propositional and procedural knowledge about teaching which, according to Shulman & Elstein (1984), is the decision making knowledge base for a person.

The fifth section of the case study is the determinants of the curriculum, which assesses the knowledge about long range planning a subject held. The associated conceptual patterns of the subject integrates the knowledge about teaching held, and presents an indication of the subject's potential for learning to become a more effective teacher from teaching experience.

Each case study concludes with two summary discussion sections. First, the subject's conceptual patterns found in relation to each of the five issues with a potential for learning from course experiences or teaching experience defined to address the first purpose of this study is presented. Second is a summary of the three data sources as a means of defining subect's concepts about teaching; the second purpose of this study.

Following the presentation of the picture of the expert and three preservice teachers through the descriptive case studies, a summary comparison discussion was made addressing both of the broad questions of this study. This was followed by Part II, which was a contrasting summary presentation and discussion of the similarities and differences found for all the subjects: the finding of this study in relation to the two study purposes. The chapter concluded with a summary of subjects' patterns of conceptions found in relation to those of an effective secondary science teacher and conclusions of the effectiveness of the three different data sources in relation to assessing concepts held by study subjects.

To facilitate data presentation and discussion, terms were used in abbreviated form. Methods course referred to the secondary science methods course the subjects of this study took. Subject referred to preservice secondary science teacher, and effective teacher referred to established effective secondary science classroom teacher unless otherwise defined. Quoted materials were primarily taken from the initial clinical interview transcripts of subjects unless otherwise noted. The following list specifies the abbreviations used for designating quoted material data sources:

Data Set Quote Source	Abbreviation
Initial Clinical Interview	I. I.
First Lesson Plan & Recall Interview	I. P. R.
First Microteaching Lesson Transcript & Notes	I. M. L.
Final Clinical Interview	F. I.
Class Instruction Field Notes	F. N.
Class Instructor Interview	I. C.

Part I: Descriptive Data Presentation: The Case Studies

An Expert's Description and Views of Teaching

Professional Status:

The methods course instructor was a professor in the department of teacher education at a major university, with many years of high school and college teaching experience. Dr. K. had been publically recognized for his professional expertise as a high school teacher, he had been honored as the state's outstanding science teacher. Dr. K. had over ten years of experience as the instructor for both elementary and secondary science methods courses at a major university. He was nationally recognized for his work as a science educator by such contributions as authoring a science textbook series, research publications, and contributions to the development of the national association's policy statement on the goals for science education. As a qualified expert, Dr. K.'s concepts about teaching illustrate an effective teacher who can articulate the essential knowledge about teaching as defined by research and by personal experience.

Dr. K.'s prior experiences and knowledge were the bases from which his mental schemata or framework for teaching had developed. This mental framework about teaching was called upon in two very different ways as he assumed the responsibilites of teaching the methods course. His own actions as a teacher arose out of this mental framework, and secondly, the content of the course was derived from it. In designing and implementing the course instruction, the unique set of dispositional, propositional and procedural knowledge about teaching he possessed provided a solution to the problems he faced, in deciding what to teach, and how to teach, and when to teach it, to encourage change in a group of students. His knowledge and experience base determined his thinking, or decision making process, which defined both a set of actions for himself as a teacher, and defined the type of thinking and actions he wanted his students to learn and to demonstrate in order for them to function as effective teachers in their future classrooms.

The Problem for Interpretation of the Course and Nature of a Teacher's Work.

The most concise statement of the problems Dr. K. believed his students had, which he addressed through instruction, were defined within the set of goals and objectives for instruction he presented in the course syllabus. They were:

> "1. To acquaint future secondary science teachers with the concepts of modern science education, the processes of inquiry in the sciences and the methods whereby these can be effectively taught in the secondary school.
> 2. To describe the nature of science in such a way that it is consistent with science education literature.
> 3. To classify teaching episodes as to their probable effectiveness in teaching attitudes, concepts, and processes and to justify their classification system.
> 4. To derive objectives of science education from the nature of science and the psychology of learning.
> 5. As a result of course experiences, the students should be able to:
>
> —Identify major components of the newer secondary science curricula.
> —Describe conventional secondary science curricula and compare them with newer curricula.
> —List and describe the science processes.
> —Demonstrate detailed knowledge of the newer curricula in at least one area (general science, biology, chemistry or

> physics).
> —Identify divergent questions and state their proper use in secondary science teaching.
> —Contrast and compare the contributions that Jerome Brunner, Robert Gagne, and Jean Piaget (have made to) teaching techniques through demonstration lessons (microteaching).
> —Describe an acceptable laboratory organization for secondary school science." (F. N.)

Dr. K.'s objectives were not a set of isolated actions, theories, competencies, attitudes or beliefs about students, science content, milieu, or teacher. Rather, teaching was presented as a complex task involving multiple variables which need to be given consideration by an effective teacher in order to determine the course of action that will be followed.

Dr. K.'s goals presented broad groupings of specific dispositional, propositional, and procedural knowledge about teaching that integrated multiple factors about students as learners, scientific knowledge as curriculum, and the teacher as the classroom leader whose responsibility it is to bring students and content together. This knowledge base was essential in order to function as an effective teacher, and it was this that he wanted his students to incorporate into their mental framework for teaching.

Idealized View of Teaching

Dr. K.'s stated objectives for the methods course presented teaching as a complex task of interaction between a teacher, students, and content. When asked how he would determine who was a better teacher by observing several teachers in classrooms he stated,

> "Well, first of all I'd pay a lot of attention to what the students say, and not so much to what the teacher says. The reason I'd say that is that, what evidence do I have that there's students learning? Is there any evidence that there is any intellectual interactions; student-student and teacher-student. If the teacher is just lecturing all period I really don't know anything and I don't have any evidence that there is any learning. I think that straight lecture for more than a couple of minutes at a time is inappropriate on the secondary level. You don't know where the kids are without this interaction.... There are all kinds of levels of interactions and if the interaction is excellent you will have good student questions coming out.
>
> In other words, the teacher has to interact with the students; ask them questions and the dynamics of the lesson ought to produce student-student interactions and student questions. And I put a lot of value on high quality student questions. They show you that they (students) are not only there with you, but they are ready to move on to the next concept. So that's my evidence that they have comprehended the prerequesite concepts and are ready to move on. So it is evidence of student learning that I am looking for." (I. C.)

Dr. K. viewed successful instruction as resulting in students comprehending and demonstating they understood presented concepts. However, this end result was presented as contingent upon the appropriateness of the presented concepts for the students to learn which were linked to the teacher's understanding of the students mental condition in relation to content. The successful teaching task was described as a complex set of interactions in which students and a teacher influence each other and are mutual determiners of the task's successfulness. The role of the teacher, and the role of the students are contingent upon each other in multiple interrelationships.

The Role of the Teacher: Dr. K. presented the teacher's role as something beyond one who only lectures about content to students.

Rather, the teacher was presented as an interaction facilitator and lesson pace controller in the description of successful instruction. In addition Dr. K. believed,

> "The most important role of the science teacher is teaching kids how to think and a lot of this, then, is learning a conceptual network well enough to apply it to many different situations. I think that is the power of science and I think this is the most important part of science teaching... And I think the master teacher is one that can get a high percentage of the students understanding the content without loosing the top 20% of the students."

As a teacher of science instruction Dr. K. said,

> "I'm most concerned about their (students) prerequesite knowledge. Their past knowledge and how well they understand that to go to the next step. And this is where pacing comes in. So very, very important.. That if the person does not have the information base and you keep moving away from that person and the pacing is just always two steps ahead of him you'll eventually loose him and that's my major concern all the time.
>
> The second major concern really is how can you manage. This is where I consider a teacher a social engineer. It is really social engineering. How can I manage the top 20% and keep them intellectually involved enough to stay interested while I am trying to bring along a higher percentage of the students. And often times you can start putting sequences together, really trying to put the storyline together where you ask your low level questions to the bottom half (of the students) and then at the end you ask one of the top 20% to put ot all together and see if they've been awake or dreaming about the basketball game." (I. C.)

Dr. K.'s responses presented two key patterns of beliefs about aspects of the teacher's role. First, the teacher is not only the classroom interaction facilitator, but also the instructional leader with the tasks of planning and implementing activities in order for mental changes to occur in the student. Second, the teacher is a "social engineer" or manager of the environment.

As an instructional leader the foremost task of the teacher was to design learning experiences appropriate for a given group of students. This task involves making decisions about what, when, and how to teach scientific knowledge content. The teacher defines a sequence of scienctific concepts in a manner which facilitates the development of the student's conceptual network related to a scientific topic. The teacher determines an appropriate delivery system for this content as a series of activities which will mentally engage all students in the content, and continuously provide the teacher with feedback about an individual's level of understanding, or the mental conditions of the students in relation to the scientific knowledge content.

As the social engineer the teacher's primary task was to manage student behavior. To Dr. K. this meant keeping all students mentally and physically engaged in the instructional tasks, by using techniques such as questioning for refocusing, and continuously assessing the students for feedback to determine pacing of instruction. Dr. K.'s management decision was based on a central concern for student learning and mental activities which in turn defined the standards for acceptable behavior in the classroom.

In summary, Dr. K. believed the role of the teacher was to create and implement educational experiences that a) continuously accounted for the student's level of understanding about content, b) that addressed students as individuals with sometimes differing learning needs in relation to content, and c) would result in students' ability to use acquired knowledge in problem solving so that the solution would be congruent with the scientific knowledge base. Dr. K.'s central beliefs expressed about the role of the teacher were synomomous with those described in educational literature as that of a conceptual change teacher (Anderson & Smith, 1985).

A Role for Students: As defined by Dr. K.'s response about successful instruction (see p.69) students were to be "intellectually involved" in a lesson. They demonstrated a role of being active responders to instruction through such behaviors as "raising good questions", answering the teacher's questions, and interaction with each other and with the teacher. However, the scope of the students' responses was not confined to the immediacy of the teaching situation by Dr. K.. Instead, he believed the students' responses told a teacher about the students' mental condition in relation to science content learning, and that this mental condition was an essential element in the teacher's decisions, about what subsequent "steps" of content should be presented, when "steps" of content should be presented, and how to present the content of the "step". Dr. K.'s role for the students was that of being proactive determiners in science instruction. Proactive determiners affect a teacher's decisions by their active responses to instruction. They determine what details of content are appropriate to present as well as how content should be presented and when in instructional actions and in the planning process.

What Dr. K. viewed as appropriate physical behaviors for students was defined by his response to problems students may have in learning about science. He said,

> "I consider science easy if you teach it in an experimental mode. However, it is different than a memory course. Any science course requires students to chain things together and see the relationships and be able to use it. In other words, you can not memorize definitions in science and apply them to anything. I think that most students, that I had, thought that science was easier than most the other academic subjects.... In other words, if you look at science as a way of thinking, and if you look at science as, well, how does it grow out of my everyday experience, and how do I apply it to my everyday experience (then it is easy). This is what we do when we learn anything. So it's very easy. But if you teach science as a catalog of definitions, then the sheer volume to be learned in science is what makes it tougher than nails....
>
> The greatest problem that students have is figuring out that I want them to think and not to memorize. So I think the real problem in any inquiry subject is just changing their (students') views of what learning is and schooling is. I think what makes it easier for them is to base most of the concepts on their experience either in lab or demonstration. And I keep telling the kids you don't need to know anything in this class, when you come in, except how to think. And you think with me through this class, and it's easy. And if you're setting there writing down all those stupid words, and a definition for them, while I'm trying to teach you to think then you're memorizing terms. You and I will be going in two different direction. That's the toughest part then, to convince them that you mean it. It's virtually impossible to memorize chemistry. It's a logic course and even physics is, and any of your conceptual networks that you have in science." (I. C.)

Students were expected to interact with each other and with the teacher while doing experiments, watching demonstrations, asking questions, and actively listening. The students' role was that of proactive determiners in instruction by being mentally and physically active responders in instruction.

The Idealized Teaching Picture: The Dispositional Knowledge Base of Teaching

A summary of Dr. K.'s beliefs about the role for the teacher and students in science instruction creates a picture of a science classroom which has a consistently high degree of interactions occurring in relation to content through a variety of directed, purposeful activities which include laboratory, application problem solving activities, question and answer sessions, and discussion. Students clearly are on task, mentally engaged, and involved in learning to the extent that they seek further information about the content being presented.

The student's role in Dr. K.'s classroom was that of proactive determiner in instruction. Students are mentally and physically active during a lesson and their mental condition in relation to content is an essential decision making factor of the teacher in regard to determining what is taught, when it is taught, as well as how to present scientific knowledge content.

The teacher's role is to be a creator of conceptual change in students through the tasks of instructional leader and social engineer. As the instuctional leader the tasks of designing and implementing instruction are done with the students' mental conditions as the central focus of decisions about actions to take. The social engineering task is the management of the environment to ensure a high degree of student engagement in the learning activities by each student of the class in order that a high percent of the students achieve the desired results which was to be able to problem solve in a manner which was congruent with the nature of scientific knowledge.

In this idealized view of teaching Dr. K. presents his own goals for teaching and learning theory understanding. It is representative of the dispositional knowledge part of Dr. K.'s mental framework for teaching. However, to have established goals for a task does not automatically mean that a person can perform to those set standards. Actual performance, or a person's actions, are the end result of a decision making process which requires that appropriate propostional knowledge, or information, is brought to bear on a problem in an appropriate solution strategy which arises out of a person's procedural knowledge. Thus, although the dispositional knowledge base of Dr. K. clearly defined a role for the teacher and students, it fails to provide details about the knowledge Dr. K. had and used in decision making to ensure that events which occurred in his classroom would be congruent with his goals. This is explained in the following discussion.

The decision making Dr. K. needed to do in order to define appropriate actions which would structure lessons for success involved two tasks of teaching which are planning for instruction and implementing instruction, or the teaching of a lesson. Dr. K. needed to make decisions about how he would act before he began teaching students, and while he was in the process of instructing students. Dr. K.'s propositional and procedural knowledge-related conceptual patterns, will be addressed by looking at what he thought were the essential elements in a lesson and essential frames or components of planning he made decisions about in establishing a daily lesson plan. The essential elements for a lesson or the essential frames in planning and their meanings each infer specific roles for the teacher and for students. These defined roles for a teaching situation are representative of the propositional knowledge base for teaching, while the essential planning frames defined roles represent Dr. K.'s procedural knowledge base for teaching in this study. As an expert, effective teacher one would hypothesize that Dr. K.'s defined roles for each would be synonymous across all three types of knowledge about teaching. In order to provide a base of comparison with the subjects of this study, the patterns of concepts Dr. K. presented in describing how he would plan and teach are presented and coalesced into conceptual patterns used to define a realistic picture of teaching, representative of Dr. K.'s propositional and procedural or operationalizable knowledge base for teaching. It is presented as his realistic view of teaching.

A Realistic View of Teaching

A pragmatic perception of the work of a secondary science teacher is being an adult who is in charge of, and legally responsible for an assigned group of young people, students, in an assigned classroom situation for a specific duration of time. This time is allocated on a daily basis for the specified number of weeks that seems appropriate for teaching a course about a particular science content subject area. School systems defined expectations for this adult are that 1) the situation will be a safe environment in which, 2) students have an opportunity to learn, to acquire knowledge, about a particular science content subject area, which is important for them to know in relation to living a productive life in our society (Goodlad, 1984).

Given this pragmatic perception of teaching, the teacher is responsible for the events which occur within the situation and is the decision maker about the use of the given classroom time in relation to meeting the given societal expectations for his/her work. A global problem for the teacher is what s/he will do and what the students will do with the time they are together. In planning a teacher decides a course of actions that s/he intends to have occur in the given time, while in teaching s/he make moment-by-moment decisions which determine the events that occupy this classroom time.

Essential Elements of Instruction: The Propositional Knowledge Base of Teaching

Dr. K. was asked to put himself in the position of having just completed teaching a chemistry class and to describe how he would know if the lesson(s) he just finished was successful or not. He said,

> "Well a successful science lesson, and I'll go into the sequence separately, is one where you really start with a discrepant event, either in a demo or something, usually a demo though. Where an

inconsistency from their (students') expectations was introduced and then you start getting the students to use what they have used already to really develop a new schema to account for this event. I don't think one can over emphaize the need for discrepant events. I don't think much learning is going to take place unless there is this cognitive dissonance that you cause some way. This can grow out of a laboratory, it can grow out of a visual that you have, but you have to present a problem worthy of thought and a lesson does that."

Now a sequence of lessons. A good sequence of lessons then is knowing your class well enough to develop bite size chuncks (of content) so that you can take more than the upper 20% with you in the sequence and that takes experience. In other words, what I tried to do is take bite size chuncks that would move 85% of my students with me through a series of maybe two weeks of lessons. And you can do that by assessing what they have had in various ways. Usually I would present a discrepant event and then I'd ask, 'Well what have we learned in the past week or so that might help you look at this problem?'. Then I'd kid them, 'Well if you didn't learn anything maybe we'd better go back and review that'. So we'd go back and review and sometimes I even retaught part of this. And then you have to ask the question was that helpful or was it out in left field. Is it going to help you solve the problem or not? So you keep reteaching, reviewing and applying until they really see what this next step is that they have to take intellectually. So knowing the bite size chuncks and being able to build that is the art of sequencing (a series of lessons)." (I. C.)

The first obvious concept about instruction presented by Dr. K. is that a lesson is only a piece of a much broader framework, a series of lessons, which was the base upon which he determined the successfulness of his teaching. This was supported by what he described as reasons why teaching would be unsuccessful. He said,

"Most unsuccessful lessons in my experience end up that the problem or the objectives are never clear to the students and usually it's not clear to the teacher either. It's a series of interactions between students and teachers where the student doesn't know where it's going. And therefore doesn't know if they got there or not. So I think one of the most important things for a teacher is having clearly in their mind what it is they want the students to learn during that lesson.

Another kind of unsuccessful lesson comes out of timing.

> Where the teacher might have had a good plan in mind but before it all comes together the bell rings. And if that teacher tries to pick that up the following day then there are two unsuccessful lessons because students really, unless they've come to some kind of closure on the activity the previous day, will not remember enough of the details to pick it up the following day. Some teachers are very good at having a whole sequence of unsuccessful lessons where they never really reach the objectives of any one lesson. I saw this so often in (activity based science programs). They'd do an activity but they wouldn't do anything with the information at the end and then the next day that information was cold and it doesn't go anywhere. So the pacing and the timing is so important in a lesson. (I. C.)

Thus, Dr. K.'s understanding of teaching was that a lesson was a segment of a series, which had a defined objective or purpose. The purpose was for students to learn "bites" of scientific content daily to construct an overall knowledge about a science topic.

Dr. K.'s essential elements of a lesson included a lesson set, presenting new content, student practice on new content with feedback, summary, and new advanced organizer for next lesson with the students' mental condition as the determiner of all actions to be taken by the teacher and the students in the lesson. As a teacher he was flexible and responsive, with additional optional activities relating to the content to ensure student learning. The implied teacher role represented in Dr. K.'s response was the same conceptual change creator described as a part of his idealized view role for a teacher. Likewise, the students role was centered in mental and physical engagement with the overall role being that of proactive determiners in instruction. Thus, the definition and discussion presented in the idealized view was directly applicable to Dr. K.'s propositional knowledge base of teaching as well as his dispositional knowledge base of teaching.

Essential Frames for Planning: The Procedural Knowledge Base for Teaching.

Dr. K. was told it was several months into a teaching year and asked to describe what he would do before a lesson to prepare to teach. He said,

> "My first thing when I'm getting ready for a lesson, the first question I ask is, 'Where are they as a class conceptually? What is it I can be sure that they know now?' and then what is the next chunk (of content)? What should happen? And the next question is the grabber, what's the demo, what's the discrepant event? How can I get from here to there? And then the details just worked out are next.
>
> Now the details of the lesson then are how am I going to get from the demo or the grabber to them comprehending the concept. More than what kind of questions I'm going to ask. What questions do I ask of what kid? In other words, if I don't plan that out I'll miss some of the kids that are sleepers or silent. I always kept a record of which kids I called on every day and I'd glance at that and I'd say, 'O.K. now during this week I've called on two-thirds of the kids, but this one day I called on this person and he didn't do well but I didn't check back with him yesterday so now I have planned ten low level questions, the high level questions are not going to bother me. I know I'll wait to see who is sleeping and nail them on that, but the low level questions that I have planned (to the detailed level) of who should get them. And I planned it to that much detail.
>
> Then after I've satisfied myself of 85% of the kids getting the major idea then I go back and show them how the textbook lesson that I have assigned covers that same thing in a different way. Then what the next sequence is going to be and I treat the textbook as an advanced organizer. In other words, I did it by pages not by sections and sometimes my pages were not completely sequenced. So I'd say, 'O.K. now on this assignment I'm getting you ready for the next idea and these are the major ideas that are in there and these are the things I want you to pay attention to.' Now it's still like preaching on Sunday, the people who need it most can't get it and the people that don't need it probably can read it in a couple of minutes and get the essence out of it. Textbooks are of limited use.
>
> My sequence in daily planning is always thinking back, where

> are the kids now, o.k. what am I sure they know and what's the next logical thing to cover? Then what's my grabber, my discrepant event that's going to lead them into that to get them from here to there. Then I start planning questions and I start thinking about who I should ask those questions to. Then I'll let someone wrap it up but I won't decide who is going to do that. I'll have lots of people that can do that. And then it's the advanced organizer for the next lesson and I usually will use the assignment as the organizer for the next lesson." (I. C.)

Again in discussing planning for a daily lesson an obvious concept about teaching expressed by Dr. K. was that a lesson was not something planned in isolation. There were three factors in his overall approach which directly influenced his daily planning. These were the students' mental condition in relation to content learning, the logical developmental sequence of science content in the curriculum, and teaching activities.

The procedures he used in planning a lesson were to ask himself a series of questions to define the plan for the specific lesson. Most questions Dr. K. asked in his planning process were directly correlated with his defined essential elements for a lesson. However, in daily planning the "details" were about procedural aspects such as defining a specific content-related low level question to ask a particular student. The details Dr. K. addressed imply specific frames for planning were interrelated and viewed together in his decision-making process (Slinger, Anderson & Smith, 1983; Smith & Sendelbach, 1982).

Identifying a "grabber" or discrepant event to be used in the lesson, addressed these frames of planning: objective; learning outcomes; activities; and management of materials. Presenting a problem to students implied solution of the problem, which requires defined objectives and specific learning outcomes for the lesson. These were associated with the dispositional, procedural, and propositional knowledge base of science. Activities selected were based on their merit in relation to acheiving student learning results, while the use of demonstrations implied that materials were accounted for, and readily available for appropriate use during instruction. Developing questions at specific levels and for specific students implied that Dr. K. made decisions based on consideration for individuals students' responses as well as collective group responses. The questioning also implies that assessment of students was a continuous process which influenced his decisions about what occurred in the classroom. What was absent in Dr. K.'s details was his failure to address a time frame associated with planning for instruction.

When probed for this he said,

> "To me in daily lesson planning I don't worry about time except for pacing, total time. I don't want the bell to ring before I get my advanced organizer in. I'm worried about pacing and not total time." (I. C.)

Thus, not to make detailed decisions about time was significant in relation to what was of central importance to Dr. K. in teaching. He wanted flexibility in pacing new content delivery to assure that a large percent of the students learned whatever scientific knowledge content was presented. Learning outcomes were more important than to complete the coverage of specified content for a course. He also wanted to assure that his students had closure to a lesson, and that they were given advance notice of the direction that the sequence of instruction was following.

In summary, Dr. K.'s planning decisions addressed frames of planning as interrelated factors associated with decisions made in relation to particular elements of the lesson contributing specifically to the goals for student learning. His frames and meanings given to them again presented the role of the teacher and students as a conceptual change creator and proactive determiner respectively.

A Realistic Picture of Teaching

Since Dr. K.'s defined roles for the teacher and for the students were synonymous with those defined by his idealized view of teaching, the picture of his realistic view of a classroom looks just like the idealized view. What was evident in Dr. K.'s responses was a great deal of cognitive consistency across his three types of knowledge bases about teaching as expressed in the interview responses. The student's role was to be proactive determiners. They were mentally and physically engaged as active responders in the lesson, and through their mental responses, provided feedback about their mental conditions in relation to content, which was a critical factor in the teacher's decision making processes while teaching or planning to teach. The teacher's role was to be a creator of conceptual change in individual students in the classroom.

Determinants of the Curriculum.

To understand what knowledge he thought was important to have for decision making about a course, and how this knowledge was acquired, Dr. K. was told to put himself in a situation where it was August and he was just hired to teach chemistry. He was then asked to describe what he would do to get ready to teach. He said,

> "Well I've taught in 5 different districts so I have some experience in doing this. The first thing I do is find out what my tools are: you know what's there, what's the science equipment, and I found the fastest way was to take inventory. And from there you can start to see where it is possible to conduct individual labs on particular areas and what you have to demonstrate. So after you know what your tools are, then I try to talk to some of the teachers and find out where the kids are. In other words, I found a great variety of levels at which different students operate in different schools. If you can't find a science teacher in the summer, you find an English or math teacher and see if you can chat with them and see where the students achievement would be. And after that, you guess, but you put the sequence together and I plan the entire year. And then change it when you meet the kids and see what you really have.
>
> Then I start with what am I going to do the first 6 weeks in detail. I want to make sure my laboratory sequence could go and so then I probably spend some time back in the school and throw the stuff together for the first three labs and make sure I have all the details for the first three labs and then I'd start planning my lessons and see how I can assess them both in lab and demonstrations and teaching. And I'd probably teach them for two weeks and then reassess where they are in my own mind and what size chunks I can take and how I can make some gains on the chunks. Then really about Thanksgiving time you have to reassess them again to make sure that 85% of the kids are getting the major ideas. And if you don't reassess about this time then you may have misjudged the knowledge base (of the students) and it may influence the whole year."

In long range planning, Dr. K. listed key factors important for teacher decisions in planning as resources or "tools" he had to use in teaching, and the general abilities and competency of students in the school. The determinants of the curriculum for teaching included a combination of knowledge Dr. K. brought to the work situation about students, content area knowledge, and teaching strategies, as well as the content of the textbook to be used.

Summary View of Dr. K.'s Patterns

How an effective teacher thinks and acts was the problem presented for the course interpretation by Dr. K.. His response was that the nature of the teacher's work is complex with multiple tasks to complete and multiple variables, or factors, needing to be considered in the completion of teaching tasks. The role of the teacher was to design and implement instruction in a manner which resulted in conceptual change in individual students, and to manage the students' learning environment.

The role of the teacher, in Dr. K.'s view, was to design and implement educational experiences which continuously account for an individual's and a groups' mental condition in relation to learning science. The teacher was a creator of conceptual change in students. The student's role was to be a proactive determiner of instruction by active mental and physical responses. The students' responses were central determiners of what occurs, how it occurs, and when an activity was determined as useful for inducing student learning by the teacher. The students, along with resources available for teaching in a particular situation, were determinants of curriculum for a class. However, two other significant determiners the teacher brought with him/her were the teacher's knowledge base about details of the science and a collection of science activities which can be used for teaching particular topics of content. Dr. K.'s knowledge about teaching was detailed, and often very specific. He presented no obvious gaps in his different types of knowledge that were a part of his mental framework for teaching. His realistic view of teaching suggested that his propositional and procedural knowledge base were comprehensive enough for him to operate at his idealized view of teaching level.

Case Study One: John

Professional Status: Now and Future

John was a junior in his fourth year of university study. He was an earth science major and physcial science minor as areas for teacher certification, but also intended to get a second major in geology, minor in geography, and certification as a mapmaker. John believed he could teach "anything if I put my mind to it." He was asked what he thought he would be doing 20 years in the future and said,

> "God only knows. I can't even imagine where I am going to be next year. I've only had two jobs in my entire life where I got actual paychecks. I worked at the sporting goods store for three years straight and then I worked at the bike shop for two summers. But you know, it is like I said I don't have a lot of experience in classrooms. If I don't like it I'm sure not going to stay there. At this point I can see myself teaching 20 years from now....I'd like to be teaching somewhere, but then again if there are no teaching jobs, and I get a job making maps for someone, I might be there for twenty years. It is really hard to say. My first preference at this point is to be a teacher." (I. I.)

Although John expressed uncertainty about the future, if he could get the job of teaching, his goals were,

> " I had a really good earth science teacher in ninth grade and I look back on that and I say, 'ya, that would be neat.' You know teaching ninth graders that. So I think of myself teaching ninth graders, but I suppose that depends on the school....I like earth science, but I've had good chemistry teachers so I wouldn't mind trying to teach that, or maybe, I had a bad physics teacher so I'd like to prove this could be done better. Generally earth science is what I would really like to teach but you know I'd branch out. I really like geography too. I think geography is very important and I don't think it is emphasized enough... I don't think our high school had any geography whatsoever, so I think that is a hole that needs to be filled. That's another reason I am in teaching. You know, it is like I see some voids and I'd like to fill them. I see some areas for improvement so I'm going to take it upon myself to fill in those areas." (I. I.)

Thus, John's held view presented himself as potentially being a teacher in a variety of different content areas. He seemed very confident that he could be a good teacher, but was concerned about job availability and even had alternative careers, such as mapmaking clearly in mind. He would teach and remain in teaching if he liked it. What aspects of the work John understood as he began the methods course were explored by asking him about his rationale for becoming a teacher.

John was first asked why he wanted to become a teacher and then why a science teacher. He said.

> "Both of my parents are teachers, so I guess you can kind of say it is inborn in my blood or something like that... I've been in school all these years and I've gotten used of the hours and these hours I want to keep. The pay may not be the best but I couldn't get many jobs with better hours.....
>
> I like to read English, like my Dad teachers, but it is not my favorite subject. I really enjoy history. I really like history, but I know there is a lot more openings for science teachers than history teachers." (I. I.)

John's stated rationale for becoming a teacher contained only the external rewards associated with teaching. He never mentioned central features of the nature of the work, such as liking to work with young people, sharing science knowledge with others, making a contribution to society, or factors associated with the people oriented nature of teaching. His reasons for becoming a science teacher implied that in choosing a profession he was looking at what the work could offer to him personally rather than what opportunity he had to offer something to others through his work. The work of the teacher was seen by John as having hours he liked and wanted to keep, implying that the nature of a teacher's work is such that it may be effectively done within the hours of the school day. Thus, to John a teacher's work was viewed as relatively simple task when he began the course.

To understand what John knew about the nature of the teacher's work as he completed the course in relation to how he understood the nature of the work at the beginning of the methods course, he was asked to describe what the differences were in how he approached, planned and taught the first and last microteaching lessons to the sixth grade students. In his exit interview John said,

> "I don't know how to explain it, but I know (in the) first microteaching lesson I came out of it and I just had this feeling, 'Ya! this is what I want to do. This is great!' You know it was just neat to have the kids learn. I don't know but I had a decent crew (group of sixth graders) the first two times and the last two times I had some rats (students) in there. Ah, but I mean still, even when I had the bad kids I didn't come out of it thinking this is horrible and I want to leave and I want to quit." (F. I.)

When probed further for any differences between the first and last microteaching experience he said,

> "I guess, if you look at my grade (given by the instructor for each lesson plan) the answer is no. It was kind of consistant in a way. I guess I felt the first one was just so unorthodoxed. You know, just to do it. Not given what we were to be doing or who we were teaching, but I mean just, you know, I've got to do it (teach sixth grade pupils a lesson from batteries and bulbs unit). You know who am I going to teach, and what am I going to teach, and in the last one I had like an idea of the kids and kind of what to expect." (F. I.)

Thus, John addressed very few factors of teaching in his description of the differences between his first and final lessons. John's naivety and lack of knowledge about the the nature of a teacher's work he had upon entering the course was directly confronted in the teaching experience. What he learned was that it involved working with students, and that students are not all alike. These were two things that he had not considered as a part of his decision making process about becoming a teacher, and were not included in his knowledge base of teaching when he began the methods course.

A summary view of what John believed the nature of teaching was when he began the course, was reinforced, and which was expressed even more clearly in the final exit was,

> "Well, it made me a little more prepared for what to expect when I go out to student teach. I don't have a whole lot of actual in the classroom, in the teaching type of experience. I've been a salesman which is essentially the same as being a teacher. I know a lot of teachers would cringe when they hear me say that, but well, I sold sporting goods and it required the transfer of information a lot of times. I had to tell them why they wanted to buy this. In fact, I was teaching them something about this, so that they would be informed purchasers." (F. I.)

Thus, upon entry to the course John knew little about the nature of teaching beyond that it had, what he perceived, were good work hours associated with it. He saw teaching as a simple task of presenting information to students. Students were viewed as all alike in the classroom group context. John implied that the work of the teacher does not require a lot of effort beyond school hours to be effectively completed. John was confident that he could do it and could teach anything if he "put his mind to it."

The Problem for Course Interpretation

The multiple majors and minors which John was pursuing in college were indicative of what John stated as his current life philosophy;

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"Don't close any options.". His concerns over the future and limited understanding of the nature of the work of a teacher seemed to suggest that John entered the methods course with a problem statement related to career exploring, such as the question, "If I choose to be a secondary science teacher what would it be like?" The accuracy of this hypothetical question as representative of the problem John defined for himself to solve by taking the methods course was supported by his exit course interview responses.

When asked to tell how he felt prepared to teach after the course John said,

> "The only thing that worries me about teaching is that I'm afraid I took this class too soon. See I'm not going to student teach for another year so I'm thinking, 'Golly, how am I going to remember all this for over a year?' Actually I've got a plan thought.... I think I am just going to sit in on this class again next fall. I figure I'll sit in on it again and then I'll be up for student teaching." (F. I.)

John seemed to say that after the course was over, and he had decided he really wanted to become a teacher, the knowledge he was exposed to in the course had a very different meaning than when he first experienced it. It was almost as if John said, "Now that I've seen what secondary science teaching is like, I will need to redo the course to learn how to be, think and act, as a teacher.". Hence, John had defined a different problem than this for interpretation of the course experiences the first time he took the course. The problem of career choice exploration also was supported by John's previously presented comments about what he learned from microteaching. Something he learned from microteaching was that even if "kids were bad" he still felt like he wanted to be a teacher. Thus, from John's responses it is clear that it was only after he decided to become a teacher, following the course, and he perceived himself as facing the real world of teaching in student teaching, that the "how to do it", dispositional, procedural and propositional knowledge of the methods course became important for him to know. When John began the course with a problem of not being certain about his career choice for the future, what he seemed to do, and be most concerned about, was to get a good grade rather than concentrate on acquiring a better understanding how the effective teacher thinks and acts.

What John said he wanted to learn from the course was,

> "Well, from the title alone, science methods. How to teach the stuff and make the kids learn it. How to write tests that are reasonable. Just general class stuff; keeping (kids) in line and discipline and things like that." (I. I.)

Thus, even what John said he wanted to learn from the course were broad general statements about knowledge related to understanding what it would be like if he chose to be a secondary science teacher; the problem he wanted to solve by the methods course experience.

The Idealized View of Teaching:

John's rationale for becoming a teacher, and problem for the course suggest that John knew little about teaching and that he, personally, believed that he had little relevant experience in relation to teaching. What he did know and held as his goal was explored by asking him to tell how he would determine if instruction of another teacher he observed was successful. John described his ideals for good instruction as,

> "I would say student attentiveness would be really important. I would say go out and make the students want to learn. That goes right along with basic observation of the class, attentiveness. If they want to learn they will be attentive. If they don't then they won't. (I. I.)

Clearly, in John's response the goal of successful instruction was to have attentive students. It is the student's behavioral responses which reflected the successfulness of instruction. However, it was the teacher who was responsible for making the students want to learn.

The Role of the Teacher: When asked to tell what he believed was the most important role of the teacher John said, "You know, present the subject in an interesting manner which makes kids want to learn the materials." Thus, the teacher's role was to be a presentor of science content knowledge to students.

How this was ideally done was defined by John as,

> "I'd say go out and make the students learn. I think he'd spend most of the time talking with, or to the class, as oppossed to say like handing out worksheets every day and letting kids fill out worksheets and things like that. I'd think, you know, lecture is a little hard at that age, but occasssionally assigned readings and then discussion of the assigned readings and maybe occassionally you'd have that. Homework assignments and things like that, but, you know, have discussions of things like that. Projects and demonstrations you know that go along with talking to and with the class. Demonstrations are always good attention getters. And if you can provide a demonstration you can make a kid like to see how things work, so I am a big fan of those." (I. I.)

The pattern of beliefs John presented for the role of a teacher was a learning facilitator; someone who talks with and to the students using a variety of activities including demonstrations as a means of getting students attention and giving them a reason to learn science content.

When asked what he would be most concerned about in science instruction John stated,

> "Whether they are learning the materials, whether that be because the material is at their level and whether I'm doing a good enough job of teaching it and whether they want to learn it. I guess my main concern would be are they listening." (I. I.)

In other words, the teacher's role is to be that of a learning facilitator, by selecting and presenting appropriate science content through a variety of activities which are appropriate for getting students interested in science content, and maintaining student attention during instruction.

<u>A Role for the Students</u>: From John's expressed beliefs about successful instruction, and how this can be done the students were individuals the teacher talks with and to. Students were physically active responders to instruction and learned if they were interested in what the teacher presented. This role of active responders was something John restated when he addressed the problems he thought students would have in learning about science, and what he would do about it as a teacher. He said,

> "You know, students look at scientists as kind of strange and especially at junior high you'd think I'm never going to become that and I'm never going to have anything to do with science so why do I want to be here? Why do I have to take this class? I'm never going to use this and that goes along with learning attitudes and values. You know it's like not only do you have to learn about this, but I also want them to know why and what they can use this for. So it is important that people know why they are learning something as opposed to just telling students to learn something. So I guess along with attitudes the thoughts about why am I here, why am I suppose to be learning this, and the

> other problem will be, am I teaching to their level, am I dealing on a level they can understand so they can learn". (I. I.)

In other words, John viewed students as being a homogenous group, whose role was to be active responders on a physical behavioral level in instruction. John believed that if students were interested and physically active in the lesson, then learning automatically occurred.

<u>The Idealized Picture of Teaching</u>: A summary of John's beliefs about science teaching presents a picture of the teacher presenting science content to students through the use of a variety of modes, such as textbook reading, discussions, demonstration, lecture and laboratory activities. In these presentations of science propositional knowledge content the teacher gives students a rationale for the importance of content in relation to their lives.

Students are a homogenous group, whose role was to be physically acitive responders in instruction. Their interests, attentive behaviors, and participation in activities were believed, by John, to be indicative of mental engagement and learning was considered an automatic result.

The teacher's role was to be a learning facilitator by designing and presenting instructional activities selected for their appropriateness in relation to the level of the students. Lecture as a teaching mode was considered limited, and the emphasis was on discussion and demonstrations as modes for giving students new content, and a reason to learn science propositional knowledge content. Successfulness of instruction was determined by students' attentive behaviors, which were correlated to a teacher's ability to present instruction in an interesting manner which makes students want to learn.

The Realistic View of Teaching

Clinical Interview Data Source

Essential Elements of a Lesson: John was asked to put himself in the position of being an earth science teacher who had just completed teaching of an earth science class lesson and to describe how he would know if the lesson, or series of lessons he just finished teaching was successful or unsuccessful. He said,

> "I guess part of it would be student interest. And personally I'd ask the kids. I'm all for student-teacher evaluation. So I'd let them tell me...so maybe after every subject you could hand out a questionaire asking did you like this, did you like this and so on. That would be helpful...but good instruction also, I mean, I suppose test results show. If kids learned the stuff that is good instruction. Test results have something to do with it. Unsuccessful instruction would show up on test results, too, but then comes the question of who is at fault. Is it the kids because they are not learning? Is it me because I'm not teaching well? Is it me because I'm teaching something they can't comprehend anyway, you know, regardless of how well or how much I teach.
>
> I think an unsuccessful lesson would be, well, I guess, a prime example would be to get sort of specific like if a teacher handed out, you know, here is your homework. Your worksheet for the day. He handed it out and then just sits in front of the class and does nothing. Then the kids don't do it saying, "Oh, we'll do it when we get home," and they just sit around and do nothing and that is not grounds for successful teaching." (I. I.)

Thus, John held that student interest and attentive behaviors were the factors which determined the successfulness of his teaching on a daily basis. A series of successful lessons was determined by student test results, and by John surveying the students for their likes and dislikes in relation to his teaching.

Another one of John's concepts about teaching was that a lesson was considerd isolated and independent, rather than a segment in a series with something significant to contribute to make the series successful. It was only in relation to the series as a whole that John felt he was accountable for student learning outcomes. Continuity was not essential in teaching according to John. The only essential element of a lesson John stated was the presentation of new science content to students.

This one essential element implied that the role of the teacher was that of content presentor. This was supported by John's response about his concerns in relation to his microteaching experience. He said,

> "It sounds kind of scary to me. Just the feeling that I'll look like an imbecile. I won't know what I'm doing. I don't know, it is hard for kids because you are supposed to be a teacher. You are supposed to be an authority and there are these kids that come in and they are like thinking this idiot doesn't know anything. I know I've a couple of professors like that and I know it has really irritated me. Well, my God, this doesn't know anything. He knows less than I do and he is teaching the course, you know. So I don't know, I guess it is like good old Piaget or someone like that said, it's the fear of failure...and, well, I guess related to this (microteaching experience) is a substantial part of the grade in the (methods) course. So they go hand-in-hand and I guess if you do well you'll get a good grade and if you don't do it well, I don't know how he (course instructor) grades that." (I. I.)

Thus, the role John held for the teacher was that of being a content authority who presented scientific knowledge content to students in the way he was most familiar from college experiences - the lecture mode. John implied that the students' role was that of passive recipients.

Students were to pay attention and not misbehave.

<u>Essential Frames for Planning</u>: In daily planning for a lesson John said, what he would do was,

> "I'd want to review the stuff myself and make sure I knew what was going on. Say I assigned them textbook readings or something. I'd hate to have a kid ask me a question and not know the answer or something like that and lose my credibility. So I'd want to review the materials, prepare demonstrations or anything else you might have. So prepare for demonstrations and try and anticipate questions that might come up. I suppose your first year you might not know what, but after a couple of years you could start thinking about what questions they may ask so that would help you along." (I. I.)

John's response addressed the frames for planning of 1) management of materials, 2) selecting activities, and possibly, 3) sequencing of content. The implied role of the teacher was to be a content authority who presented scientific knowledge to students through an inferred lecture mode linked with demonstrations. The role for students was to be passive recipients of the information present with no mention of mental engagement in learning content presented, even though John stated that students may ask questions. He was concerned about being able to answer these questions from his perspective of maintaining credibility as a content authority, and not in relation to students' learning by questioning.

Plan and Planning Recall Interview Data

<u>Essential Elements of a Lesson</u> (See Appendix B for Lesson Plan): John was asked to describe how he imagined his planned twenty-five minute microteaching inquiry lesson would occur. He described his

planned lesson as,

> "Well I am going to say something like, 'Today we're going to learn about electricity.' And then I was going to say, 'What in your house runs by electricity?' And get some student responses on that and then of course I wouldn't try to make the distinction between the fact that those all run on AC and we're going to deal with DC, but you know, once again in just 25 minutes it's just not enough (time). But anyway that's kind of the thing I was going to ask them, 'What do you know that is run by electricity? I figured we could go from there maybe into some simple circuits, drawing circuits on the board and things like that. And then we could get out the box of stuff, wires and you know, 'If this is the circuit we have on the board, which part of the circuit is this and how does this connect up? Where should I put this?'....
>
> Then we could, uhm,... I hadn't really thought of a specific they could do because, I mean, I thought if I just had a set for every kid I might just give it to them and let them play with it for awhile. You know, try things out.
>
> As for discussion and summary, I'd probably just grab up everything they'd been playing with cause otherwise your're not going to get their attention if they have things to play with. I'd collect the materials back up and we'd discuss. Maybe we'd go back to the cirucit diagram and see (if they could tell me which ones work.)." (I. P. R.)

The essential elements of a lesson as presented by John were: 1) a lesson set, 2) new content presentation, and possibly, 3) a practice activity, and 4) a summary. However, in assessing the relationship between John's opening activity for the lesson in relation to the new content presented his question, "What in your house runs on electricity?", fails to assess knowledge students had in relation to circuits, as well as fails to establish a specific direction, or mental preparation for the lesson in students. A third problematic nature of this activity, in relation to being a lesson set, was that there was no apparent use by the teacher of the information acquired in the remaining parts of the lesson. Hence, the two essential elements of a lesson clearly presented in John's planning recall response were 1) presentation of new content to the students, and 2) a summary of the content presented as a conclusion to the lesson.

Lesson actions related to these elements were the teacher's drawing of some circuits on the board and explaining them to the students by lecturing. Then, using the science lab equipment he built a demonstration circuit for the students with them parroting back to him the information he had just presented. His discussion summary was a reiteration by students of this same lecture content to the extent that the same diagram on the chalk board was used. These lesson actions presented by John define the teacher's role as a content authority who presents scienctific knowledge to students using a teaching strategy in which activities confirm content as presented by the teacher. The students' defined role was that of passive recipients on both a mental and physical level. Demonstrations were used to confirm content, and not as a means of developing mental changes, or learning, in students.

Essential Frames for Planning: John was asked to describe what he thought about and did to formulate his lesson plan. He began by saying,

> "I don't know, it looks kind of thin (his lesson plan, see Appendix B), but I guess, I had a few questions after I sat down and started to write it. I thought well, gee, oh I got to think about this and I couldn't do it. First of all, are we going to have one of those boxes (of materials) for every kid?
>
> I figured I'd do a little demonstration and then I 'd let the kids play with it (materials) for awhile.... I also wanted to know if there was a blackboard. That's part of the discussion and summary. I didn't really write everything. I don't know, I've never really written a lesson plan before so I don't know what I was suppose to do." (I. P. R.)

Then looking at the plan itself, John said,

> "Well, I just thought, how would it start and you know, you've got to say something to them to get it going. And what would I say and then how would I talk about electricity and see what the kids know already? And then I'd try to work up to a demonstration and then I'd try to work on how I could have a transition from the opening to the demonstration. And then I was wondering what we could have the kids do. So that was where I wondered if I could have one (set of materials) for every kid to have one or if I just had one set. Or what could I have them do just on my set. What could I have each kid do? You know what could I have each kid try? And then as a discussion and summary I was wondering where I could, like do I want to hand out one of those little test type things (from the teacher's guide) and see if they can draw circuits and things like that. I didn't really want to make them look like, you know, here's this new teacher. He's going to give us homework. I don't want to be a tough guy my first time out." (I. P. R.)

The planning frames John clearly addressed in his lesson plan recall were 1) management of materials, and 2) management of student behavior, as they interrelated to, 3) activity selection and 4) the teaching strategy. The fifth frame addressed was assessment, but as it related to John's lesson it had a questionable meaning.

In the written plan (See Appendix B), John also addressed the frames of objectives and time. However, the one stated objective was vague, with no specific scientific knowledge content defined, hence, it was a questionable lesson objective statement. Time was presented as being used in relatively uniform segments across the lesson. The only meaning of this frame was clock-time. Time for activities were not determined with a consideration of pacing of content for student learning results by John.

The role of the teacher implied by John's addressed planning frames was that of a manager of the classroom activities, or activities director. No clear learning outcome goals were connected to this role, but the teacher was a presentor of science content through lecture and demonstration as a part of the teaching strategy. The purpose of the activities seemed to be to provide students a chance to "play with the materials", to possibly keep them occupied, and maybe avoid discipline problems for the teacher. This lack of a clear purpose for activities implied that students were mentally passive recipients in relation to the new content or learning, while their physical behavioral responses were the greatest concern apparent in John's decisions in the planning process.

Microteaching Lesson Data Source

(For a detailed account of teacher and student actions in the lesson see Appendix B)

Lesson Summary: John began his lesson with the introduction among the students and the teacher. He began instruction by telling the students, "O.K. Today I am going to try to teach you a little bit about electricity. So this is science. We're suppose to be teaching you about science". A student's immediate response to John's opening statement was to ask, "Is there going to be fun things to do?" To which John responded by saying, "Sure we're going to have lot's of fun things to do!"

John then moved on to ask his question and to get students to present to him a list of things in the house run by electricity. He listed these responses on the chalkboard.

Next, without having discussed the list, John began a chalk talk, or lecture on a simple circuits. During the chalk talk John drew a simple circuit on the board, and explained a light bulb and the central concept that a circuit is like a circle. Following the chalk talk John asked the students to complete a worksheet in which they were to draw in wires on schematics to complete three examples of circuits. The students were confused over John's directions and each had difficulty completing the task. John monitored the students and helped those having difficulty as they completed the worksheet.

He collected the worksheets prior to the students completing them. As he collected them he said, "Here, I'll take these and now we can get to some real fun stuff. I'll let you play with some real circuits."

The students responded excitedly with several volunteer comments and were obviously disappointed when John proceeded to demonstrate the construction of a circuit using the materials himself, explaining each piece of equipment to the students and their function in the circuit as he built it. During the demonstration the students made comments seemingly trying to hurry him along. However, John ignored the students and continued as he had planned.

Following the demonstration, John gave the students the materials, without directions, and they immediately began to build, but had a lot of questions about how to use the materials. The students were given approximately 15 minutes of the lesson time to work with the materials. As they worked, John monitored, assisting individual students, answering student questions, and commenting on types of circuits, such as a short circuit which one student constructed.

John concluded the lesson by giving the students a second worksheet, which he called a test. This last worksheet was distributed to students when there was only about one minute of classtime remaining. The students again were confused over the directions given and hurriedly completed it with no feedback given in relation to their work by the teacher.

John's lesson overran his allotted class time by approximately five minutes. He just collected the student work sheets and told the students they would go for a walk now, so his partner could prepare for the second lesson.

Essential Components of a Lesson: In John's actual teaching of an inquiry science lesson, the essential elements of the lesson included, 1) the presentation of content, and 2) students doing activities with little structured or systematic feedback. The science content introduced by John was less than that which the students introduced by their own questions. The outside trained observer's comment on John was, "students were not attentive... sometimes students manipulated the materials, but it was only to copy what the teacher showed them."

This brief overview of the lesson suggested that the teacher's role was primarily that of content authority who directed activities for students. The students were passive recipients in relation to the new content the teacher presented, but were physically engaged in activities they were told to do by the teacher. They led the teacher to present new content by accidently creating situations, or asking questions, which required the teacher to respond and explain the student problems as a content authority. Thus, the role of the students was that of passive determiners of the lesson based on their exhibited physical behavioral response during instruction. There was no clear requirement or structure in the lesson by the teacher to ensure that students were mentally engaged in the content. Learning which occurred was more by coincidence than by design.

Essential Frames for Planning: The microlesson events clearly illustrated that John had made decisions about instructional actions related to several frames. These included: 1) activities, 2) teaching strategy, 3) management of student behavior, 4) management of materials 5) assessment, 6) time and 7) sequencing of content. John's decisions made, however, in relation to each of these frames were inadequate and insufficient to result in a successful lesson. There was little new content presented to students. Indeed it was unclear that John had any learning outcome goals in mind for the lesson. Since such little new content was presented the sequencing of content was not clear. Most learning that occurred resulted by coincidence, rather than because of John's plans for the lesson. The reason for activities seemed to be to provide students with a opportunity to be involved and have fun in the lesson. Hence, the activity selection base was defined by a concern for student behavior management, or discipline, rather than learning outcomes. Time was a problem in relation to John completing the final activity in his lesson, the intended post-instruction assessment. Management of materials and student behavior were problems especially in relation to providing students with direction for use of materials. John had a sufficient number of materials for students, but they were not designed to adequately achieve their intended function within the lesson.

The role of the teacher defined by the frames addressed and their meanings implied from the lesson was that of activity director and content authority. Designing instruction for specific efficent use of classroom time in relation to learning outcomes was not clearly evident in John's lesson. The students' role was that of physically passive determiners, i.e. students were told what to do by the teacher and their resultant (anticipated and exhibited) behavioral responses were critical factors in decisions made by the teacher about appropriate action directions for a lesson. Mental conditions, or engagement of the students, in relation to new content was an insignificant factor. Hence, students lead the teacher by what they did, or said, as a result of something the teacher told them to do. Learning which occurred was a coincidental result of students responses for the most part throughout the lesson. The teacher as a content authority responded to student's initiated lesson content directions, i.e. student introduced content questions, or lab results, determined the majority of the new science content presented in the lesson, rather than the teacher defining it ahead of time.

<u>Summary: Essential Elements of a Lesson Comparison of Data Sources</u> (See Figure 4.1): The only essential element of a lesson John defined for all three data sources was the presentation of new content by the teacher to students. The primary teaching modes John used to present new content were to lecture and demonstrate science content to students. The teaching strategy employed was to use a demonstration as a means of illustrating and confirming the content presented in a lecture. The role of the teacher was a content authority presentor and the students' role was physically and mentally passive recipients in science instruction.

The microteaching situation, however, defined different roles for both the teacher and the students. In the microteaching lesson, when John employed his lecture followed by demonstration strategy, the students' behavior responses resulted in John assuming the role of a content authority who directed activities with no clear learning direction provided to the students by his reactions. Learning was coincidental and accidental for the majority of the classroom instructional time. Students' behavioral responses determined what occurred once the teacher initiated the lesson. The key source of scientific knowledge content presented in the lesson arose from activities and student questions to a teacher, which initiated a teacher

Figure 4.1 Essential Elements of a Lesson - John

Data Source	Clinical Interview	Plan and Recall	MicroLesson
Essential Elements	Presentation of New Content	? Lesson Set Presentation of New Content ? Summary	? Lesson Set Presentation of New Content and Modeling ? Practice with Feedback
Teaching Strategy	Lecture Demonstration Sts Activity	Lecture Demonstration Sts Activity	Lecture, Worksheet Demonstration Sts Activity Worksheet
Teacher's Role	Content Authority Presenter	Content Authority Presenter	Content Authority and Activity Director
Students' Role	Physically & Mentally Passive Recipients	Physically & Mentally Passive Recipients	Physically Passive Determiners

? Questionable meaning and use by subject

Figure 4.2 Essential Frames in Planning a Lesson - John

Data Source	Clinical Interview	Plan and Recall	MicroLesson
Planning Frame Used	Management of Materials Management of Students ? Sequence of content	Management of Materials Management of Students Activities Teaching Stragtegy ? Objectives ? Assessments (Pre) Time (clock)	Management of Materials Management of Students ?Sequence of content Activities Teaching Strategy ? Assesments (Pre&Post)
# Used	3	7	7
Teaching Goals	Propositional Science Knowledge	Propositional Science Knowledge	Occupy Student/ Fun Learning Coincidental
Teacher's Role	Content Authority Presentor	Content Authority Presentor	Content Authority & Activity Director
Students' Role	Mentally & Physically Passive Recipients	Mentally & Physically Passive Recipients	Physically Passive Determiners

? Questionable meaning and use by subject response. Hence, the role for the students was physically passive determiners of instruction.

Summary: Essential Frames for Planning Comparison of Data Sources (See Figure 4.2): When John knew he would actually teach students he addressed more frames of planning in his decision making process than when he just talked about teaching (3/7) (see Figure 4.2). The meaning John gave to the frames had insuffcient details to create an effective mental set for him to act out of in teaching. For example, the objective defined for the lesson was, "To instill some knowledge of electrical circuits." This was a vague objective. It failed to specify what scientific concepts would be presented, and what students should learn as a result of the lesson. John's teaching strategy was simple with no alternatives available to replace or modify the one identified. This did not allow him to be flexible in his teaching, as was illustrated by the way in which he presented new science content.

Other frames were also incomplete and insufficient with limited meanings, and resulted in problems during the instruction. The limited learning that did occur was a result of students' responses to John's assigned activities. John's role as the teacher, and role for students followed the same pattern across data sources as that which was defined by the essential elements of a lesson. As defined by John, planning was not a very complex mental procedure. It consisted of chaining a series of activities together to keep students involved or occupied behaviorally, with one activity being the teacher presenting a little new propositional science knowledge content to students

The Realistic Picture of Teaching

John, as a classroom teacher, would not be highly concerned about his teaching unless students did not do well on tests. He would survey students to know what they liked or disliked about his teaching as a means of improving it. Thus, daily accountability for student learning outcomes, as a result of instruction, was not a concept of teaching that John acted out.

The picture of his classroom would be one where few purposeful, directed activities occurred. Typically, John would lecture on some new science facts as content and then engage students in busy work; worksheets, text reading, and laboratory activities. The busy work was more for keeping students occupied to avoid behavioral problems then to promote learning or understanding of the content presented. John's concerns about avoiding behavioral problems was the basis used in deciding what should be taught, how it should be taught, as well as, when it should be taught. Learning in John's classroom would be accidental, and not the intentional results of the teacher's thinking and decisions about a lesson.

The best teacher's role that John defined was that of content authority presentor. Played out in the actual teaching showed this to be the teacher as an activity director and content authority who primarily presented new content in the lesson only in response to students' actions or questions. John's defined best student role was that of mentally and physically passive recipients, while in the actual teaching situation (microteaching) the role students exhibited was as physically passive determiners. In other words, the students ran the show.

Determinants of the Curriculum for a Course

John held himself accountable for students' learning only in relation to a series of lessons based on test feedback. A daily lesson was viewed as isolated and independent with no clear learning outcome in relation to a series of instructions. To understand how John incorporated such a view into school system expectations for a classroom teacher, he was asked to tell what he would do for long range planning in relation to teaching a course.

John was told it was August, and he had just been hired as the new earth science teacher in the school district. He was asked to describe what he would do prepare to teach students coming in September. He said,

> "I guess the first thing I'd do is try and sit down and think to myself, well, I guess I would want to look at textbooks and if they had a textbook I'd want to read it and decide how much of the textbook I wanted the kids to look at and in what order. I'd sit down and basically decide like for the year what I wanted the kids to learn. I wouldn't sit down and write lesson plans for the year, but I'd think about what I wanted them to learn in that year and what order that I felt it was necessary that they got it in. Then I would try to arrange for demonstrations and exercises and things that I knew they could work to be in with that, that they were working on. And basically that's about it. But you know, I'd try and get a plan and to get an order of things that I wanted to go through for the year." (I. I.)

The set of key parameters John would establish for later decisions in relation to instruction were a set of learning goals, and a sequence of content directly related to the course textbook. The textbook content order would be adjusted in relation to his own knowledge about science and teaching brought to the situation. In addition, John would make a collection of activities (demonstrations and exercises) he could use to teach the content. The only determinant, related to the situation which John felt he needed knowledge about for making decisions about the curriculum for a course was the textbook. What to teach and the how to teach it were based on the textbook. When it would be taught was influenced by the knowledge John brought to the particular teaching situation.

Summary of John's Conceptions of Teaching Patterns

John entered the methods course thinking that teaching was a simple task. His problem for course interpretation was to figure out what it would be like to be a secondary science teacher so he could decide if he wanted to be one. The textbook was the key factor in John's decision about course curriculum.

His idealized view of teaching, representative of his dispositional knowledge of teaching, defined the teacher's role as a learning facilitator who made students want to learn propositional scientific knowledge by presenting it in an interesting manner, using a limited, varied set of teaching modes, and telling students how the science information would be useful to them in their lives to encourage them to want to learn it. The role of the students was that of being physically active responders, i.e. students were ideally attentive, and involved in the activities by such behaviors as taking notes or participating in discussions, textbook readings and laboratory exercises. Students were considered as a homogenous group with differences across grade levels, but not among the individuals in a class. John's idealized view represents the goal he would strive for, and be satisfied with, if he were given a classroom of students to teach earth science to when he began the course.

The realistic view of teaching, representative of John's propositioanl and procedural knowledge base of teaching combined, defined the role of the teacher, at best, as a content authority presentor who presented scientific propositional knowledge to students by lecturing to them and used science activities to occupy and inolve students in the instruction. Learning which occurred was by coincidence, by accident, rather than design because John never accounted for students' mental conditions in relation to what science content was presented, when it was presented, or how it was presented. At best, the students role was that of physically and mentally passive recipients.

However, in actual instruction (the microteaching lesson), the role of the teacher became that of content authority and activity director; someone who primarily presented new science content to students in response to behaviors exhibited by students which initiated a need for the new science content. In other words, students were physically passive determiners in instruction. They did what the teacher told them to do, and their behavioral responses to the activity determined the purpose for the activity, and the direction for the lesson. Thus, the students lead the teacher, determining what new science content was presented and when it was presented. Learning which occurred was more coincidental than carefully arranged by the teacher.

Summary of Data as Sources for Concepts

John's idealized view of teaching and realistic views of teaching determined different potential pictures of classroom teaching. John's knowledge base for teaching had gaps in it between the dispositional, and the combined propositional & procedural (operational) knowledge bases. His realistic view, constructed as a composite of propositional and procedural knowledge presents a picture where, at best, the teacher was an instiller of science facts, and, at worst, was a director of activities designed to occupy students. There were no differences in the picture defined by John's responses for when he was given a teaching task situation, from that of a clinical interview planning task through a written plan and discussion of formulation of the plan. However, there was a different picture of teaching defined by his actual classroom performance (microteaching lesson).

Thus, John's dispositional knowledge base was not operational given his propositional and procedural knowledge of teaching upon entry to the methods course. The key differences as far as potential classroom teaching ranged from someone who would keep students occupied by giving them activities to do with virtually no intended learning outcomes, to someone who would facilitate learning by presenting content to students in an interesting way which included a variety of teaching modes and purposeful activities. Even with this later picture, John's goal of teaching leaves much to be desired in relation to how an effective secondary science teacher thinks and acts. John had two serious gaps in his mental framework for teaching which could prevent him from being an effective teacher. First, a gap existed between his ideal or dispositional knowledge and that of a effective teacher. Second, was a gap within his own knowledge base for teaching between his dispositional knowledge and the propositional and procedural knowledge he knew in relation to implementing his ideal or dispositional knowledge.

Case Study Two: Ray

Professional Status: Now and Future

After graduating with a degree in fisheries and wildlife, Ray, a fifth year senior, decided to stay an extra year at the university to pursue teacher certification in biology and physical science. He was asked what he thought he would be doing twenty years in the future and responded,

> "Well let's see, that's a good question. Twenty years from now I image myself being a high school biology teacher. Although I don't know if I'd be teaching the general biology, which when I was in ninth grade in high school they taught general biology and then you worked into the other classes like genetics and things like that. I'll be a biology teacher unless I can combine some type of teaching position with some other kind of a nature program like working in a nature center or some type of state run program, but still involved in teaching." (I. I.)

Thus, Ray had a clear picture of himself as a biology teacher to use as a reference as he took the methods course.

In part, what Ray understood about the nature of a teacher's work was presented when he discussed his reasons for choosing a teaching career He said,

> "When I was a junior; the fall of my junior year I had an internship in a nature center and they actually have quite a large enviromental education program there run with the (local) school system where they start out with preschoolers and go through sixth grade. Each grade level has a different program that they go through, and it just built upon stuff they've learned before. I was there for a whole term, about twelve weeks, and I really got interested and had a lot of fun. So I talked to some people in the department here and I figured fisheries and wildlife was what degree I needed. Then when I started looking for a job, all of the jobs that I thought I would want were being filled by people with master's degrees, so you pretty much had to go on to graduate school to

> get the type of job that I was interested in, so that kind of left me hanging there. So I figured that after my internship I found teaching rather interesting, so I figured to go into that. I found myself having a lot of fun working with kids, and that is kind of what I figured I had gotten into fisheries and wildlife for. I might as well do something that I enjoy." (I. I.)

Ray's intern experience, and the lack of a job without a graduate degree were central in his rationale for a career change. From the internship in a nature center program Ray's rationale for teaching included both pragmatic reasons in relation to training, in getting a job he liked, and the nature of teaching such as liking kids.

To understand what else Ray knew about the nature of the teacher's work as the course began, he was asked to describe the differences in how he planned and taught his first and last microteaching lessons to the sixth grade pupils. In his exit interview he said,

> "Well, I learned that you have to try real hard to get students to learn anything. At least the students I had. The last time, last week, I had a hard time keeping them under control. I had to think up so many questions in a short time, and I had to shoot one at each kid all the time, but if I was shooting one at one kid, another kid is over there talking or goofing off. So I had to shoot a question over at him to get him to pay attention, and then the other person over here starts talking, and I'm just going back and forth on that. You could see smoke coming out of my ears. I was thinking so hard of questions. And I just, you know, you really have to put a lot of effort into it to get it to go off well and that's the big thing that I figured out as a teacher. It's not as easy as it looks. No! When I was in high school I was, you know, the teachers were always prepared, you know, they always got all of their stuff done and no problems. So this is an easy job, I should be able to do this, but I didn't know all of the preparation that goes into it. Now I know.
>
> "The first one (microteaching lesson planning), that one was easy to plan because, I don't know, you had all of the circuits and stuff and everything was right there. All you had to do, well, I didn't have to put a lot of effort into the

> first one to get it to go off well, to get it to go off at all. And, you know, the first one I didn't know what to expect so I didn't really, you know, know how much effort I should put into that and I don't think I was gonna present the material and stuff, but it didn't take me very long to figure out.
>
> The last one took me quite awhile to figure out how I was gonna present the stuff because, you know, the ideas of variables and thing like that are hard to get across. And if you don't present it in the right manner, you know, the kids are just going to look at you say, "what?" And it took me awhile to think of the right questions to ask, to see if I was getting the ideas across....I suppose if you switched the teaching around, if you did the whirlybird first and the electrical circuits last it would probably end up the same way, because I probably wouldn't worry so much about the material (content) in the whirlybird if it was first. So I guess, it's just what I've learned in the class in the ten weeks that I figured out that you have to think up the right questions and the right ideas to get it across" (F. I.)

Thus, Ray discovered in the course that teaching, "Was not as easy as it looked." His first lesson was described as easy, because he was relatively unconcerned about making sure his pupils were learning the science content of the lesson. Therefore, Ray entered the course believing that teaching was a simple task of deciding and presenting a sequence of activities to students.

The Problem for Course Interpretation

Ray's prior experiences, as a nature center intern, were most significant in his decision to become a teacher. What Ray knew about the nature of the work of a teacher, and how he felt prepared to teach also was directly related to this experience. Ray used this context to explain what he wanted to learn from the methods course as,

> "I think I am prepared in that I have such a, I think anyways, a theoretical base and I think I'd be able to work from there

> and use that. I guess you have to understand the concepts pretty well before you can explain them to any great degree so that someone will understand you, but you have to get down to their level and explain it to them in a way that they'll undertstand. I tell you I learned a lot about that when I worked at the nature center because most of the people I took around on tours were less than seven or eight years old. I took some preschoolers around, and if you don't keep them occupied all the time they are just off in space. They are not even listening to what you're saying and it took me awhile. I had to take a couple of those tours around before I got the hang of it, but it was a lot of fun trying to figure out how to keep them occupied all the time and keep them interested in what we were doing. The guy that runs the nature center was real good at this stuff, so he kind of gave us a few points. Like for the real small kids you couldn't take them on a real long tour.... there wasn't too much you can explain cause they wouldn't know what you were talking about...and then as they got older they would become more aware of what was around them and you could explain a little bit more. So I want to learn exactly how I am going to teach it (science). How I am going to get it down to their level. How do you go about setting it up and things like that."
> (I. I.)

As Ray began the course he was aware of how younger students (K-6) respond in a teaching situation and had acquired a set of teaching techniques to effectively maintain younger students' interest and keep them occupied in a lesson. What Ray wanted from the methods course was a set of teaching prescriptions that would allow him to do the same with older students in a science class. His problem for the course was to learn details of exactly how to present science material on the students' level in a manner which got them interested in learning science. He was primarily concerned about learning how a teacher acts, rather then how the effective teacher thinks, or arrives at decisions.

The Idealized View of Teaching:

Ray's understanding of the teacher's work and problem for course interpretation suggested that teaching students in a manner which maintained their interest so they learned and they were kept occupied were central factors in successful instruction. Other central beliefs that Ray had about teaching were assessed by asking him to tell how he would determine if the instruction of another teacher, he observed was successful. Ray described ideals for good instruction as,

> "For one thing I'd have to see if the students were paying attention to the teacher. If they were paying attention and taking notes, I guess that the teacher would stop everyone once in awhile and see if there were any questions, and, I guess again, you'd have to base it on the type of questions that are asked. You know what the kids are thinking about, and how they answer questions that the teacher asks. It would have to be the depth of the question. I mean some questions you can't ask unless you know what the material is about. You can ask elementary questions, but if you don't really understand the deeper questions you know there may be something that you don't know further down the line. And if you're not that far yet, then you can't ask that question." (I. I.)

Thus, Ray believed students' physical attentiveness behavior and mental engagement in the lesson were essential for success. The teacher was a presentor of content and assessor of students' learning.

Ray described his high school biology teacher as the model he wished to emulate in his teaching because, "I really enjoyed it." What Ray's high school biology teacher did was,

> "Let's see, for biology I would say, when I was in biology my teacher spent about half the time on lecture material and then he had discussions sections that lasted about, let's see, we had fifty minute periods and he would talk for about thirty-five to forty minutes and then we would spend the rest of the time discussing the material that he'd gone over.

> We didn't do the same every day. I mean, sometimes we'd have experiments and demonstrations and you know just different things to do. I mean it wasn't all lecture. You just can't do that, especially in high school. You can do that in college because that's all I get now. Well, usually, I guess, there was some type of demonstration going on like in the biology class we would either be dissecting a frog, if we were on that type of subject, or look at slides of plant tissue or something like that. Usually the lecture would go along with demonstration that day. So that if there were any questions that we had about the lecture we could usually get them answered in the demonstration time. It wasn't like him standing up in front and saying are there any questions. He'd go around and check and also it depends on how he felt his teaching was going.
>
> Sometimes he would vary the length of the little question period. Like, if, the students weren't getting it he wouldn't talk too much on the lecture on the board. He would spend most of the time going over the material he had already taught until the students learned it." (I. I.)

Ray believed a good teacher was an effective science content lecturer who used a variety of activities with his students to substantiate and support what was presented in lectures and keep students'interest. The successfulness of the instruction was the responsiblity of the teacher, while the goal was to have students understand science content presented at a "deeper", or greater level other than memorization of the facts. Ray believed learning should occur in each lesson of a series, and that a teacher's instruction could be evaluated based on occurences in daily instruction.

<u>The Role of the Teacher</u>: The teacher's role described by Ray in the successful lesson was someone who knew science content and translated it to an appropriate level of understanding for presentation to students. What Ray decribed as the most important role of the teacher was,

"I hope that the students I teach will not only learn, or memorize the thing that I am saying, but will also form an interest, maybe, in what I am saying. It's always easier to learn if you have an interest in what you are doing and hopefully I can present the program well enough that they will become interested and want to learn more." (I. I.)

The teacher was a science interest developer as well as a learning presentor. The teacher's role was to design and present science content in an interesting enough manner that students wanted to learn more about science then the science content presented by the teacher

How Ray believed this was done was presented when he described what he would be most concerned about in science instruction as,

"Motivation... How I would keep them motivated. I guess in a science type course there is, from what I remember in high school, a lot of lab work and most of that was individual or in groups of two or three or whatever. And, you know, right there is quite a motivator. Except for general biology, which is a required course for everybody, the higher science classes, those are mainly the kids that are going to college in those classes, so they were pretty much motivated to learn. So from what I remember, all the guy did was hand us the material for our demonstrations, like he showed us how to dissect a frog or a cat and we had to do it pretty much on our own, and he just walked around and made sure we were doing it pretty much right. So we pretty much were learning on our own. I thought it was kind of difficult for some people if they didn't know what they were doing. Sometimes, every once in awhile, I would get a lab partner that didn't know what he was doing, and if I got confused about something I would always raise my hand and say, 'Hey, come over here.' and he would show me what I was doing wrong. But some people, you know, if they weren't real motivated, they would tend not to raise their hands right away and they would just sit there and kind of wallow in their misery not knowing what they were doing. And if the teacher didn't notice that right away then the person would get behind. So, I guess, that would be what I was most concerned about in science instruction." (I. I.)

Added to Ray's concepts about the teacher's role was that of motivator, which resulted in a descriptive pattern of the teacher being a learning facilitator; someone who knows content and translates it into instruction. This also encompasses the use of a variety of activities designed to motivate students to want to learn about propositional scientific knowledge content and confirm the content presented by the teacher. The teacher was a learning assessor who insured that students understood content at a higher level than rote memorization.

A Role For Students: As presented by Ray in his response concerning successful teachers, the students were both mentally and physically active responders. Such a role for students was restated when Ray addressed problems he anticipated students could have in learning about science. He said,

> "In terms of difficulty that's kind of hard for me to answer, because I always found biology quite easy, but it is the physcial sciences that I found difficult, like chemistry and physics and things like that. Yes, from what I've heard and the students I have associated with, I do think it (science) is difficult. For those type of classes I have always had to study a lot harder than I did for say literature or English or something like that, because I think the concepts in it are more difficult. They are a little deeper, and they are bigger. There are a lot of little details that have to be ingrained in your head before you can understand the whole concept. So I think that is why they are so difficult.
>
> I would hopefully get them (students) to understand the concept, not just memorize the details, but I suppose I'd like them to not only memorize the details, but to understand the concept as a whole. So I suppose I'd break them all down into as small as pieces as I could and then try to interrelate them to make it clear and clearer (for students)." (I. I.)

Ray, therefore, viewed students as learners who sometimes had individual differences and needs which he as the teacher must account for in his design for instruction. The role of the students was that of mentally and physically active responders in instruction so that they not only memorized science knowledge content, but were also able to understand "whole" science concepts. Ray believed student learning was an individual process and the teacher needed to check frequently to see that it was occurring.

The Idealized Picture of Teaching

A summary of Ray's dispositional knowledge based conceptual patterns about the role of the teacher and role for students presented a picture of a classroom where the teacher was the learning facilitator, and students were mentally and physically active responders in the science instruction. The teacher, as a learning facilitator, designed instruction by translating science concepts into details and presented these to students in a logically interrelated manner throught a varied set of activities aimed at motivating students to learn, and thereby verifying the propositional science knowledge presented in lecture. The goal was for students to learn the propositional science knowledge at a level higher than rote memorization. The teacher also monitored for individual student's problems in learning. Hence, Ray views the classroom of students as a heterogenous group of learners with varying learning needs to be met. The students were to be mentally and physically active responders in instruction, demonstrating behaviors such as asking questions and discussing concepts. The teacher, however, was the one who Ray identified as responsible for the success of instruction based on "how well he/she presented the program" (propositional scientific knowledge) to students.

The Realistic View of Teaching

Clinical Interview Data Source

Essential Elements of a Lesson: Ray was told to put himself in the position of being a biology teacher, who had just completed teaching a general biology lesson, and to describe how he would know if the lesson or series of lessons he just finished teaching were successful or not. He said,

> "I suppose you have to base it on the feedback you get from kids. Like the questions they ask, or you ask them and how they answer them. Then I guess if it's real well you are going to expect them to ask certain questions. You know, if they know what they are talking about, they are going to ask certain questions. And if it is not going very well and they don't ask certain questions, then you will know that they are not learning the material, and so it is not going over as you are going to have to do something different." (I. I.)

Ray held that a teacher was accountable on a daily lesson basis. He did not address differences for a series of lessons. Ray would consider his teaching satisfactory if the students were mentally active and were responding to instruction with their own questions or answering his questions. Successful teaching was determined by students mental responses, which were contingent on the teacher's ability to appropriately present science content. Ray held that the teacher was responsible for good or bad instruction on a daily basis.

The essential elements in a lesson inferred by Ray's response were: 1) the presentation of new content and 2) practice with feedback activities. The role for the teacher was that of content presentor and learning assessor. The role of the student was that of mentally active responders, with learning of science propositional knowledge content as the goal for successful teaching.

The Essential Frames of Planning: In describing what he would do to get ready to teach a lesson, i.e. daily lesson planning, Ray said,

> "I suppose I'd have to plan pretty much what I would want to teach on a weekly basis. I think you first have to make a long term plan of what you what to teach, and then you'd have a short term plan depending on how your presentation is going over. So you would have to make out a long term plan on the material you wanted to teach, and then, say you have a test afterwards, and then just work day-to-day, and try to follow your long term plan if it is feasible. Then if you have to stop and go over some things you know a couple of days or whatever.
>
> I suppose first, for what you are going to teach that next day, you have to write down your general ideas of what you want to get across. I'm not going to put down details or anything, but a list of things that you want to present in an orderly fashion so it flows together well. And, well, you want to put it down so you go from the beginning to the end in an orderly fashion so that you are not going off on tangents somewhere and confusing your students. I guess you would want to put down on paper the things you were going to talk about at the beginning of class. Like you want to tell your students you are going to talk about this, this, and this, Then you would put down the actual material you are going to lecture on after that. Like the main points, like on plant parts, the external leaves, stems, etc., and then after you did that you'd go into the internal parts like monocots and dicots and stuff like that. Basically, I guess, you are going to use that just like a note card so you can see what you are talking about, but you should already have the information in your head. So you don't need to put everything down on paper because you can't just sit in front of the class and read it. So you just want to put down the main little points on paper to remember how your lesson is going to flow for the day." (I. I.)

Ray held that, for planning, a lesson was a segment in a series which had an overall science content learning goal. In short range planning the frames he addressed and their meanings were: 1) objectives, general ideas to get across, and tell class at the beginning of the lesson; 2) sequence of content, logical development for lesson flow continuity 3) teaching strategy and 4) activities which are interrelated with the sequence of content to create a mental set to stay on target and, 5) management of materials; including preparing class notes as reminders about lecture content points.

The implied role of the teacher was to be a science content authority and presentor mainly through the lecture teaching mode. Students' implied role was that of passive recipients who were told by the teacher what was important and were accountable for presented science content in a long range testing assessment plan.

Plan and Planning Recall Interview Data

Essential Elements of a Lesson (See Appendix B for Lesson Plan): Ray was asked to describe how he imagined his planned microteaching science inquiry lesson would occur. He described it as,

> "Well, I figured after we introduced ourselves I'd say something like, I think I'd have them show me how to set up a circuit, to have them demonstrate to me if they could do it. And then if they could do it fine. Otherwise, I'd go over it again and go from there with the circuit puzzles.
>
> I'm going to have the materials out there, and I'm going to use the light bulb for the circuit tester, and I'll hook the battery up for that, and then I'll give them the puzzles, and I don't know, I suppose I'll just give it to them and let them experiment. See if they can figure it out for themselves. I don't know, it's going to be a trial and error thing, and I'll have them touch the points (of the puzzle), and see if they can find the circuits, and then when they have found them all I'd have them diagram it, and see if they can tell what is in it. Afterwards, after they've diagrammed it, I'll open it up and show them what was in it.
>
> Then, (end of lesson), well I guess I'll have an overview of what we went over; what they learned. Ask them what they think they've learned (in the lesson today)." (I. P. R.)

An essential element of the lesson, as described by Ray, was the lesson set. As Ray described the lesson, he did assess students' mental conditions in relation to science content planned for his lesson, but he did not establish a goal or mental set in students in relation to new content that would be a part of his lesson. Despite Ray's anticipation of varied students' responses to the lesson set activity, he did not take these responses into account in subsequent lesson elements, and he did not have adequate lesson objectives, or teaching strategies in mind to effectively use the lesson time for student learning.

A second element in his lesson was that of providing students with practice in applying science knowledge and subsequent feedback to them. This element came prior to the introduction of the new content, which was to learn how to record data or diagram a circuit. Ray did not describe having students practice with diagramming, hence, it was unclear whether he failed to consider this as new content for his students, or if he thought a teacher's confirmation of one diagram was sufficient feedback about students' learning of this content.

The final element Ray addressed in his lesson was a summary. This was to be done by the teacher asking students to tell what they learned. It appeared to be a rote learning assessment with no specifics related to his objectives for the lesson. Therefore, its purpose in the lesson was questionable.

Ray presented four essential elements in his described lesson. They were presented in order of their use in the lesson as: 1) lesson set, 2) practice with feedback, 3) new content presentation, and 4) summary. The meaning of the lesson set, and the summary of the essential elements were questionable. The sequence for use of the essential elements in relation to students' learning outcomes for a lesson also were questionable. Given his defined meanings, the teacher's role was to be a content authority presentor and a learning assessor who tried, but failed, to use a pre and post-assessment strategy effectively. The role of the students was to be physically active responders in laboratory lesson components, and mentally passive recepients. Students were not required to be mentally engaged with a primary teaching mode of lecture as described by Ray. Learning was a desired goal, however, the amount of new content to be learned, and lesson structure were not conducive to either mental engagement, or in the practice of new content with constructive feedback. So consequently, very little new content was presented to students in the twenty-five minute lesson.

<u>Essential</u> <u>Frames</u> <u>in</u> <u>Planning</u>: The thoughts Ray had when he formulated his microteaching lesson plan were articulated as,

> "Well, I think I had a pretty good idea of what I wanted (before wrote lesson plan). I just didn't know how to put it in the right words, so I used the textbook we had for the class and thumbed through there to find out the technical things, and how I wanted to word it, and things like that. I think I pretty much had my ideas down, or in my head.
>
> Ok, first thing I wrote, my objectives, which, hopefully, the

first one will be accomplished by my partner already. Which is to have the students be able to write an operational definition of a circuit. And then the one I want to work on is in a circuit puzzle. And then I suppose the first thing that I'm going to go over is to rehash the circuit so that they will hopefully understand that. And then I'm going to demonstrate the circuit again, and then I'll pose a couple of questions to them, and see if they have a grasp of it. And then when I've got that done I'm going to go into the circuit puzzle. And there I'm going to hand the puzzles to the students, and ask them to see if they can find the circuits. And then after they've done that I'm going to have them diagram what they think is in the circuit puzzle. And then, if I still have time, it depends on how much time I have left, I might get into the black box. I haven't really done a whole lot on that yet. I'll work that out on my final copy (of the lesson plan). This is just my rough draft here." (I. P. R.)

Regarding planning a lesson, Ray focused on defining how he as a teacher would act with little consideration of how students were to act during instruction. Ray made decisions about the following planning frames: 1) objectives, 2) learning outcomes 3) activities, 4) assessment, 5) teaching strategy, 6) time, and 7) management of materials. Two other planning frames, sequence of content, and management of student behavior, were not addressed, while several that were addressed had questionable meanings.

Ray stated that he had defined objectives, and he presented objectives in his written plan (See Appendix B). However, the first objective he stated was for his partner's earlier lesson, and his second objective was a statement of an activity the students would do rather than a desired learning outcome. The new knowledge of the lesson, diagramming circuits, or recording of data, was not accounted for as an objective. The time frame was given the meaning of clock-time, which was uniformly divided into the sequence of activities in the lesson.

The appropriateness of filling the twenty-five minutes with purposeful learning based on only one inappropriately defined objective was questionable, particularly in relation to effective and efficient use of class time for student learning outcomes. Activities were selected based on their ability to have students practice and reinforce learning, but Ray failed to provide students with practice on the new content presented in the teaching strategy. The management of materials was addressed in terms of type and use of materials, with number of materials needed not taken into account. Finally, Ray had a plan for assessment, which included preassessment, continuous, and post assesment of students regarding the understanding of his lesson objective.

The teacher's role implied by the meanings given to the frames was that of a science content instiller and learning assessor. Ray gave the students no reason for learning the new content, but instead had them participate in several activities which had the purpose of practicing content to reinforcement learning. Therefore, his objectives, in relation to new content for the lesson were unclear. They implied that only propositional scientific knowledge outcomes were the learning results he intended. Learning "hopefully" occurs when students are physically active in lesson activities. Thus, the students' role was to be physically active responders with some indications that students' mental condition, with regard to the scientific content that was presented, would influence decisions in the lesson. There was no accounting for this in the plan. As a result students were physically active responders, but mentally passive recipients in instruction.

Microteaching Lesson Data Source

Lesson Summary: Ray's lesson began with a question designed to assess the students' prior knowledge. Students were able to explain a circuit using operational definitions. They were then asked questions which permitted the teacher to do the construction building of a circuit based on student answers. Most questions Ray used were convergent; information confirmation type questions in his demonstration of building the circuit.

After Ray had completed the circuit demonstration, students were given materials, and worked in pairs to build their own circuits.

Ray then introduced the puzzles, giving one to each student, and presenting a purpose with his directions,

> "What you want to do is to tell me which ones are connected by which ones, to make the light work." (I. M. L.)

In this activity with the circuit puzzles, Ray modeled the testing procedure with student assistance, prior to giving the students their own puzzles.

Ray monitored the students as they worked on finding circuits that were in their puzzle. As the two groups of students worked, he met with each separately to present a data sheet and explain how to record their findings. There was considerable free talking among the students about the puzzles and circuits, and occasionally Ray either posed a question for a student to answer, or answered questions asked by students. The working with puzzles consumed at least 15 minutes of Ray's lesson time.

When the students completed the circuit puzzle activity, they each had a diagram of their puzzles. Ray announced that they would discuss these, and then he proceeded to take each student's diagram and explain it in detail to the students again. Ray used convergent, confirming questions with the student whose diagram he was explaining to the group. Students got restless as the explanations proceeded, and Ray responded by changing his presentation to having students hypothesize about the third student's diagram as part of his explanation. They were all "wrong" in their hypotheses technically, but logically had made appropriate hypotheses for the puzzle. Ray confirmed each student's diagram, including the discrepant last puzzle by opening the puzzles and showing where the aluminum strips were positioned.

Following the discussion of the diagrams, students were given a "tricky" puzzle to work on as a group. They tested and hypothesized and discussed it. There were more off-task behaviors as the students determined that class was over when Ray opened up this puzzle and showed them the aluminum foil pattern. He did not have students practice diagramming as they tested this puzzle and when he introduced his question for closure, "What did you learn today", students were busy discussing an upcoming class fieldtrip and failed to answer his question. He finally dismissed them without a conclusion to the lesson.

The outside observer's notes on Ray's lesson stated that students were,

> "More engaged and active with the tasks, and the teacher used students to drive the lesson. He elicited more student talk, but still lectured." (I. M. L.)

Students were on task or engaged physically and mentally for most of the classtime. Ray refocused students when they were indivudually off-task.

Essential Elements of a Lesson: The lesson presented by Ray had a definite lesson set element which was used to determine what the students knew about circuits. What Ray failed to do was to have an alternative activity ready to use when students provided him with clear feedback indicating that they clearly understood, and could apply the concept of a circuit. Instead, Ray had them continue to practice, and provided feedback about the material they already understood.

The only new content Ray presented to students was to have students complete a data recording sheet, and diagramming the circuits for their particular puzzle. This was reviewed and feedback was provided to the entire group. Students did not practice the new content in subsequent activities, although they did make verbal predictions in one subsequent group puzzle activity. The lesson summary failed to capture or maintain students' attention. Thus, the essential components that were clearly contained in Ray's lesson were: 1) a lesson set, 2) practice activities with feedback and 3) new content presentation.

The role of the teacher was that of learning assessor and content instiller. Ray wanted to be sure his students had knowledge and used most of the class time in practice activities, presenting very little new scientific knowledge to the students. The role of the students was that of physically active responders, but for the most part, mentally passive recipients who confirmed what the teacher told them through engagement in lesson activities, and responding to teacher convergent questions. The success of the lesson was questionable given the minimal amount of new science knowledge presented to students and failure to assess their learning at the end of the lesson, or in an extension activity.

Essential Frames for Planning: The frames Ray had thought about and made decisions about for the lesson included: 1) activities, 2) student behavior management, 3) management of materials, and 4) assessment. Frames that Ray may have thought about, but experienced problems with in his lesson included, 1) sequence of content, 2) teaching strategy and, 3) time. Frames which were ignored were: 1) objectives, and 2) learning outcomes.

The activities were selected to provide students practice in applying propositional science knowledge about circuits through a variety of ways including, discussions, laboratory activities, and demonstrations. Ray also used a data recording sheet to make predictions as a process skill. However, since neither were mentioned in his lesson set or in activity directions as something for students to focus on, it would appear that they were not considered as learning outcomes or objectives for his lesson. Management of materials and students behavior were overtly thought about in planning. Ray had clear directions and many convergent questions prepared for use with the students in relation to specific instructional activities and learning assessment. Materials were adequate and directions for use resulted in no behavioral management problems.

Time was a major problem in Ray's lesson. He did not have sufficient activities to keep students engaged to the end of the time of the lesson. Pacing was questionable and little new content was included in the lesson, it was difficult to define the meaning of the time frame for Ray. His teaching strategy frame was also questionable since new content was taught to individual lab groups. It was clear that Ray considered preinstruction, continuous, and post-instruction assessment important, however, he did not adjust or modify his lesson in response to the feedback students provided him in these assessment procedures.

The role of the teacher implied by these planning frames was that of learner assessor and instiller. Students were physically active responders, but mentally passive recipients who listened and answered convergent questions of the teacher. Learning was minimal for the instruction time and clearly focused on scientific propositional knowledge about circuits.

Summary: Essential Elements of a Lesson Comparison of Data Sources (See Figure 4.3)

The essential elements of a lesson defined always included presentation of new content and student practice with feedback. Ray's

Figure 4.3 Essential Elements of a Lesson - Ray

Data Source	Clinical Interview	Plan and Recall	MicroLesson
Essential Elements	Presentation of New Content Practice with Feedback	? Lesson Set Practice with Feedback Presentation of New Content ? Summary	? Lesson Set Practice with Feedback Presentation of New Content ? Feedback
Teaching Strategy	Lecture Question & Answer Long Range Testing	Assessment Sts Activity Lecture Sts Activity Discussion	Assessment Demonstration Sts Activity Lecture Discussion
Teacher's Role	Content Authority Presenter and Learning Assessor	Learning Instiller and Learning Assessor	Learning Instiller and Learning Assessor
Students' Role	Mentally Active Responders	Mentally Passive Recipients Physically Active Responders	Mentally passive Recipients Physically Active Responders

? Questionable meaning and use by subject

Figure 4.4 Essential Frames in Planning a Lesson - Ray

Data Source	Clinical Interview	Plan and Recall	MicroLesson
Planning Frames Used	Objectives Learning ? Sequence of Content Teaching Strategy Activities ? Management of Materials	? Objectives Learning ? Sequence of Content Teaching Strategy Activities Management of Materials ? Assessments Time (clock)	Objectives Learning ? Sequence of Content Teaching Strategy Activities Management of Materials ? Assessments Time (clock) Management of Student Behavior
#	6	8	9
Goal	Propositional Science Knowledge Only	Propositional Science Knowledge Only	Propositional Science Knowledge Only
Teacher's Role	Content Authority Presentor	Learning Instiller & Learning Assessor	Learning Instiller & Learning Assessor
Students' Role	Mentally & Physically Passive Recipients	Mentally Passive Recipients Physically Active Responders	Mentally Passive Recipients Physically Active Responders

? Questionable meaning and use by subject plan and microlesson also included an ineffective lesson set and summary elements. His teaching strategy was simple, with no clearly defined alternative, despite his consideration of differing potential student responses while planning the lesson. In actual teaching he failed to adjust or modify his lesson based on feedback from students about their mental condition in relation to lesson content.

Students were physically engaged in the lesson across all data sources. However, in talking about the lesson, Ray focused on the students' role as mentally active responders, while in the plan and lesson data sources they were defined as mentally passive recipients. The teacher's role was talked about in the clinical interview as a content authority presentor who interspersed lecture with frequent assessments. In the lesson plan and microlesson data sources this changed to a role of learning instiller and assessor. The key determinant of the learning instiller role was the amount of practice in which students were engaged. However, the activities had a learning purpose peripheral to the new content of the lesson. New content was introduced in the lesson only after practicing, and the students had limited opportunity to practice that new content. When students practiced the lesson content, the teacher provided feedback. The role of the teacher was to be a learning instiller and assessor. Students were mentally and physically engaged as active responders in instruction, but had little opportunity to learn new scientific knowledge.

Summary: Essential Frames for Planning Comparison of Data Sources (See Figure 4.4)

Ray addressed more frames of planning when he did an actual teaching task plan and a microlesson, than when he talked about planning a lesson. The meanings given to the frames in each of the data sources were inadequate to provide Ray with a mental set for teaching which resulted in a high degree of learning outcomes in relation to classtime use.

Accountability for student learning in Ray's lesson was problematic because of inadequate meanings for the assessment, the learning outcomes, and objectives planning frames. Ray focused only on propositional science knowledge as desired learning outcomes across all three data sources for a science lesson. In his microteaching lesson data, and plan and recall data, the hypothesizing and use of a data recording sheet for diagramming the circuit puzzles were the only new scientific knowledge content for his lesson. Neither were considered as learning outcomes or objectives by Ray. Instead, Ray's assessment focused on student understanding of a simple circuit, which was the objective for his partner's lesson. Student provided feedback about this objective in the lesson were not accounted for by Ray either in modifying his plan, or altering his simple teaching strategy in instruction. Thus, although Ray did assess students, he did not have a functional purpose for doing so in relation to teaching.

Activities were selected by Ray for what he thought they would contribute to student learning. As consistently indicated by his plan and his teaching, activities were used to reinforce learning that had already occurred in students. However, the discussion of his teaching during his clinical interview indicated that activities were selected to confirm new science content the teacher had presented to students.

Hence, the defined role of the teacher was: a science learning instiller and assessor in the plan and recall of data and microlesson data, but a science content authority presentor in the clinical interview data. The teacher as a learning instiller and assessor related to a students' role of mentally passive recipients and physically active responders. The teacher as a science content authority presentor related to mentally and physically passive recipient roles for students.

In summary, when Ray knew students were to be his to teach, his planning for instruction focused on students' engagement in activities which had a learning purpose. However, in the structuring of the lesson, this purpose of students' practicing or learning new knowledge by doing the activity was lost. Thus, student learning was seen by Ray as the goal of an activity, but the procedural teaching knowledge to structure the instructional situation to accomplish this goal was something Ray lacked.

The Realistic Picture of Teaching

Ray, as a classroom teacher, would be concerned about students' learning science propositional knowledge only. Students were to "hopefully" learn something from all activities of the lesson. Ray would most likely present new content to students in lecture with questions after his presentation. He would select activities in which students could be physically active responders in a lesson, but would often fail to structure the timing of these activities in relation to new science content in a manner which would be conducive to students' mental engagement in the new content. Instead, he used activities to reinforce what students already understood.

He would do this because of two identifiable problems in his knowledge base for teaching. First, he did not have the propositional knowledge for defining assessment strategies, which provided him with specific information about students' mental condition in relation to new scientific knowledge content. This was evident in his inappropriate sequence of essential elements of a lesson as well as the inadequate meanings given to the lesson set and lesson summary elements. Secondly, Ray did not have the procedural knowledge to incorporate student feedback responses to assessment activities by designing alternatives within his lesson plan, or modifying his teaching strategy during instruction.

Hence, Ray would most probably function in the classroom as an inflexible teacher who maintained students on task with activities that have a purpose for creating learning in students, but whose meaningful learning outcomes for the students is often defeated by the inappropriate structuring and timing for activity use in relation to new content presented by the teacher. Ray would be a propositional science knowledge instiller who assessed learning and held students accountable for learning across time on tests.

Students were to be to actively engaged in lesson activities, but there would be little structure that required a high degree of mental engagement provided by the teacher. The role for the students would be physically active responders and mentally passive recipients who managed to memorize their way to a satisfactory grade in their science class. They would be likely to create few behavioral management problems for the teacher. Ray's students would most likely not show comprehension learning.

The Determinants of the Curriculum

Ray was asked to describe how he would prepare to teach if he was hired in August as a new biology teacher in a school district. He said,

> "I suppose the first thing that I'd have to do would be to get a group of the materials that I am going to teach. I'd have to go over the textbook that I was going to use and see the type of material that was in it. I don't intend to use it maybe more than fifty per cent of the time, because if you use it one hundred per cent of the time; if everything you taught was right out of the book there wouldn't be any motivation to come to class 'cause you could just read the text... So what I thought was important and what needs to be added to the book is first.
>
> Then, I guess, I would have to figure out the type of material that I would add to it. What I would teach that wasn't directly in the book and after I figured out what I was going to teach I'd have to go over laboratory work, experiement, and demonstrations. I'd have to figure out when and how I'd do them and I'd have to figure out way of getting feedback on whether the material was good or my presentation was going over." (I. I.)

Thus, Ray would establish a curriculum for the course by using the textbook and his own personal knowledge about science. He would establish a sequence for the content, identify activities which he could use for teaching the science content, and a system for assessing students progress in relation to the science content sequence. Information about the textbook was the only thing he needed to define the curriculum. It was a resource and not the determinant of the curriculum.

Summary of Ray's Conceptions of Teaching Patterns

Ray entered the methods course with a sharp picture of himself as a biology teacher in the future. He liked kids and viewed teaching as a relatively simple task of presenting science propositional knowledge to students. His problem for the course was to learn how to act like an effective teacher. He was looking for prescriptions for how to teach science propositional knowledge to secondary students in a way that motivated them to learn and was appropriate for the level of development of his students. Ray believed the teaching goal for which he was responsible was student learning. How he "presented a program" to students defined the success of instruction and teaching. The key factor in the teaching situation he would use to define the "program" or curriculum was the textbook provided. However, the textbook was viewed as an essential resource and not as the determiner of the curriculum. The teacher's own knowledge about science was the determinant of curriculum.

Ray's idealized view of teaching, as represented by his dispositional knowledge base for teaching, defined the teacher's role as a learning facilitator and learning assessor. The subroles included being a science interest developer, motivator of students, and content translator. Ray's goals for instruction were to have students learn propositional scientific knowledge and to learn it beyond the level of memorizing it for tests; i.e., to have students "understand the concepts as a whole".

Students' role was that of mentally and physically active responders in instruction. Instructional success was determined by the quality of questions asked by students as well as answers to the teacher's questions. Students were not considered to be all alike in relation to learning needs. It was important to Ray that a teacher structure a lesson to account for this diversity by including time to monitor individual and group understanding of content and related problems.

Ray's picture of ideal teaching was one in which a limited, but varied set of purposeful activities were used to motivate students to want to learn and understand science. The teacher's decisions related to instructional design focused on mentally engaging students in lesson activities with frequent checks for learning as well as reteaching when needed. However, the realistic view of teaching, derived from a combination of Ray's propositional and procedural knowledge for teaching, suggested very different roles for the teacher and for students. Realistically, the goal was still a desire to have students learn science propositional knowledge. However, Ray did not have an adequate teaching propositional knowledge base for defining or assessing the scientific content students knew to effectively engage them mentally in instruction. In addition, he did not have an adequate procedural knowledge base to structure the use of lesson activities in a manner that mentally engaged students in the science content of a lesson. Thus, his functional role as a teacher was that of a science learning instiller and assessor; someone who appropriately selected activities for engaging students physically in the lesson, but because of sequence for using activities, often defeated the educational value of the activity in his defined structure for the lesson.

Typically, Ray would engage students in practice activities which encompassed science content that the students already had learned. Hence, the role of the students was to be mentally passive recipients and physically active responders in instruction. Higher learning, albeit desired by Ray, failed to materialize because his teaching strategy and lesson design emphasized the memorization of scientific content.

Ray's knowledge base for teaching displayed a loose fit between his dispositional knowledge and combined propositional and procedural knowledge. His mental framework for teaching was not consistent, and the ideals for teaching he had were highly unlikely to be realized in a classroom teaching situation without specific changes in both his propositional and procedural knowledge base for teaching. Even if Ray could fully operationalize his idealized view of teaching, his acting and thinking as an effective secondary science teacher were limited. For example, teaching students only propositional scientific knowledge is an inadequate and inconsistent presentation of the nature of science. Thus, in addition to the gap within his own knowledge base for teaching, Ray had more to learn about being an effective science teacher than the prescriptions for success he entered the methods course seeking.

Summary of Data Sources for Conception Patterns

In looking across the data sources, which were the basis for the definitions for the roles of the teacher and for students, a relatively uniform picture of teaching for the teacher planning task situation and teacher instructing or microlesson data tasks for both propositional and procedural knowledge data were defined. In other words, there was little distortion of meanings given to essential elements in a lesson when derived from the planning task data or the microlesson data. It was true in the same manner for the propositional data or essential frames in planning. However, the microteaching lesson defined more frames as essential to planning, but required that more subjective inferences be made during analysis.

The greatest disparity in data sources was with the clinical interview in relation to the two actual structured teaching tasks. Less details were presented and differing defined teacher's roles and students' roles resulted for both types of knowledge bases studied.

Thus, the clinical interview data provided clearly defined patterns of concepts associated with Ray's dispositional knowledge base, but were limited in defining a propositional or procedural knowledge base of teaching conception patterns as these related to the other teaching task data sources.

Case Study 3: Gary

Professional Status Now & Future

Gary was one of the of the oldest students in the class. He had received a degree in fisheries and wildlife four years prior to returning, "to get a teacher certificate and degree in biology." He had ten years of farm related work experience prior to completing his earlier degree in fisheries and wildlife, and after completing his degree he had some experience working in an outdoor leadership school and for the Department of Natural Resources (DNR).

When asked what he thought he would be doing twenty years from now he said,

> "I would like to be a farmer, and I always will want to be a farmer, and I'm going to use teaching as a means to help me possibly migrate toward that area, and get the money necessary to get started. I won't be able to make the fast bucks in a big hurry, but I will have the summers which will allow me to do the things that I like to do. . .You know if I can't eventually move into full time farming then I would continue with teaching. My first priority is for me just to become a successful teacher, and nothing beyond that (now). I won't make a lot of money in teaching, but I hope I can find satisfaction in it. I would really like to teach a biology course. . .It is like I say, I am such a generalist that I would like to teach what I can, and make the best of it." (I. I.)

Thus Gary entered the methods course with a view of himself as biology teacher in the future. It was work he perceived that he could excell in, because of his generalist background, and he hoped it would be personally satisfying as long as he was in it, even though it was an alternative to being a farmer. What Gary knew about the nature of the teacher's work was explored by asking about his rationale for choosing teaching as an alternative career.

Gary had many reasons for switching to a teaching career. One was his "disappointment" with the DNR work, others were:

> "I do like to participate with kids after they have developed fairly well, let's say, after seventh or eighth grade. But other than that, I think the teaching profession is going to be something that I can hopefully excell in with my type of education. I am an extreme generalist, although I've taken high level courses in biology and what not. I am still not a specialist in any regard, and so I think I can put my education and my background to the best use through teaching.
>
> I want to relate to people who have an open mind, and I think I can help students in that regard. I think I know enough, and have enough practical experience, that I can help steer them (students) and direct them in a direction where they can benefit the most in whatever their goals are." (I. I.)

When probed, Gary elaborated on what he meant by steering them in the right direction as,

> "Like when I was in high school I wasn't too sure exactly what I wanted to pursue in college. In fact, I knew I didn't want to go to college, and I could be a person who could go in there (school) and my background is so diverse, I've had several jobs in several areas of the United States, and I am a common sense person. Yet I have been into environmental ecology and what not, and I have been through the ropes, and I can see where the hangups come and I think I could streamline a person's education whether or not he wants to go to college, or pursue just some vocation. I think I could take an eleventh or twelfth grader who is starting to become concerned with that (career choice), and I think I could put them on the right track. And I think I'd enjoy watching them to make sure that if they had problems that I could counsel them. I didn't get that kind of counseling while I was in school. So I think I could do the students the best good not only because I could teach them well, but I would hope they would appreciate what I was saying but also I would be more concerned with their immediate future as far as their

> continuing education, and getting into the world of business or whatever." (I. I.)

Thus, of Gary's many reasons for becoming a teacher, several were directly related to the nature of the work, besides the pragmatic goal of making enough money to move into farming, he liked to work with older kids, and believed his work experiences and science generalist knowledge base would help him counsel students about careers, along with teaching students about science. He believed it was a career he could excel in, and he was confident that he could be a successful teacher. His reasons for wanting to teach encompassed both the external rewards and the internal rewards associated with teaching. He believed that the teacher's work involved more than the teaching of science knowledge to students. The nature of the work was to help young people prepare for their future.

In his exit interview when Gary discussed what he did differently in his first and final microteaching lessons he described his entry view of the work of the teacher. He said,

> "Well, I suppose I started with the motivational activity all the time. It didn't change, but I borrowed that or just used it more (in the lesson)...I suppose I didn't really, and I still didn't at the end either, plan a lot of questions. But I did see the importance of it as I went through, because it seemed like I was asking more (questions) even if I didn't plan them. . . I don't know how you could plan any questions in advance, but if you do plan some type of questions on what you think you're going to discuss you can ask some of the questions, otherwise you get in the trap of having convergent questions. . .My partner teacher seemed like he ended up putting himself in a corner, and asking himself a lot of convergent questions (in his lessons)." (F. I.)

Gary's response suggests that he viewed the nature of a teacher's work as motivating kids to learn as he began the course. He also expressed some very specific techniques for teaching which were a part of his knowledge base about teaching as he began the course. His view of the nature of the work of the teacher was that teaching was a complex task with multiple factors and variables that needed to be considered in decision making by a teacher, when he began the course.

How he thought the task was accomplished was expressed best when he was asked if his commitment to teaching had changed as a result of the course. He said it was greater because,

> "Teaching has too many things I like. I can always continue to learn again, and I can be my own boss, in essence this is how I want to, which is new to me. I didn't realize until after I started this course that I'd have so much leeway. It's interesting, throwing together a course anyway I want it. What I thought is that I'd go in there and people would tell you just about what you'd have to do. So you wouldn't do more that just an execution of the material, instead of the person who programs the things together." (F. I.)

Despite a relatively complex view of the teacher's work in the classroom situation, Gary's initial stated perception of the teacher's work was that of someone who executed or taught what others would tell him to teach. Therefore he had a simple view of the nature of the teacher's work in relation to the activity of curriculum designing or planning, while he had a more complex view of what the work task of instructing, or teaching students was like.

The Problem for Interpretation of the Course

As Gary began the methods course he believed the leaders of the educational system would tell him what he was to teach. However, he wanted students to be motivated to learn, and to learn not only science content, but life skills as well. Gary seemed to enter the methods course searching for a resolution to the contradictory high level expectations he held for his own teaching, and for the confines he believed the system imposed on teachers. In effect, Gary seemed to enter the methods course asking the question of "How does a good teacher think and act in a way that really helps kids learn and survive within the educational system?". This hypothetical question, as representative of his problem for course interpretation, was supported by what he expressed as what he wanted to learn from the methods course.

Gary began the methods course saying,

> "I'd kind of like to get a feel for what is being already taught out in the schools, and demonstrations and that sort of thing. I can go from the textbook, and teach kids from that, that is easy. But how to set up demonstrations and do a pretty good job as far as they go, and doing it on the level that kids are into, and can be involved in; what you get into, with different experiments and that sort of thing, is the way that I am hoping the methods (course) will kind of help me out.
>
> And also, I am not really familiar with the equipment available either, so that when I go into a class situation, I'll know what I want and need to use to help me teach. Of course it also is going to help me with the microteaching. It'll help me begin to have a feel for how I can relate to kids, and how they are going to relate to science, both how receptive they are to what you have to say, and how to control them." (I. I.)

Hence, Gary's problem for investigation during the course was to acquire knowledge about limitations the system may impose upon him, and to find out how he could think and act like an effective teacher within the system. He was looking for ways to teach which went beyond the textbooks, and wanted techniques for teaching, which would allow students to be involved in instruction and help him relate to them effectively.

Idealized View of Teaching

Gary's rationale for becoming a teacher suggested that he had a relatively complex view of the teacher's instructional work task, but a very limited view of the teacher as someone who designs or plans instruction. He wanted to learn how to think and act as an effective teacher within the constraints he believed the system imposed on teachers. He wanted students motivated to learn and to be involved in instruction.

Gary's dispositional knowledge about good teaching was explored by asking him to tell how he would determine if instruction of another teacher he observed was successful. Gary described ideals for good instruction as:

> "I think in biology a lack of class participation would not be successful. Students asking questions, if you're in a lecture, but if you're in a lab I think there should be a lot of participation, and getting kids into a lot of things. So I guess there should be a lot of things in the classroom, also, you know, things plastered all over that show different fields or areas and possibilities for research or what not just going on. The repercussions of what's going on in that class should

> be evident, and what they learn should be visible, so that they can constantly see that what they are studying are the very basis for many other exciting fields. So the room should be active, with pictures and demonstrations set up. I guess probably a lot of classes you get a lot of complaints when you discuss a topic or something, but if the professor gets into an area where it is kind of rough, or dull, or something is tedious, and if he can't put the enthusiasm into it himself, you know, if he can't even just run around in front of the board, or do something, to make them think that this is exciting even when it isn't, or at least it could be fun, and there is a light at the end of the tunnel. So I think his mannerisms would be very important when you're talking about something in biology that are pretty rough." (I. I.)

Gary knew that different types of teaching strategies were involved in teaching biology if a teacher wished to teach more than factual content and have students do more than memorize. Good teaching involved using a variety of strategies as well as the teacher's mannerisms, which should display enthusiasm for the subject. Finally, the classroom should be an environment where student learning is evident, and where the nature of real world issues in science are a part of the curriculum. Thus, Gary believed the teacher, the students, and the environment were all determiners of successful instruction. However, the teacher was primarily responsible for making the classroom an intriguing place for students to be in to learn many things about life and science.

<u>The Role of the Teacher</u>: Gary presented the teacher as a generalist, who teaches the "basics" of biology to students, but also functions as a career, or life goal counselor for students. When asked about what the most important role was for teachers he said,

> "Well, I think and hope that it will be to help kids to kind of sort through what is important or what is not, and give

them the right perspective. You know there are so many things that it's like you can't see the forest for all the trees. I think in teaching, I think that is what happened to me so much of the time, that I was disinterested in some courses, and what not, because you could never see what it was all building to. Every course had its objectives, and that's fine, but they never tied it into the overall scheme of things. Students, I think, constantly need to be reminded. Even if it's, well, and kind of course even though it may jump and relate to another course, you'll eventually have and then you can tie the two of them together. You know to show that it is going to be enlightening. And that until you get all the basic parts together that you can't really appreciate what it will do for you. And so not just to study it, for the fact that some day it is going to be important but to show them constantly in examples or some way or another throughout the year how it is going to be in and what like take that course with some other course and you learn these principles what eventually it will lead to.

I know now counseling in schools may be a lot better than it was, and there are a lot more fields today than there were, and maybe people today are starting to emphasize like technology, and some of these things that are very important and what you have to learn, and I'll just have to talk to some counselors, and see how they prepare the kids and that. But I think my biggest benefit will be to streamline kids to the point where they do know. I like that in schools where they are cutting off some of the options where they get distracted. You only have so much time and energy and I'd rather keep kids on track, and show them what happens. You know, it's just like two vectors, if you have them going in opposite directions that is as far as you are going to get, but if you put one on top of the other, you get twice as far. And just let them realize that is what they are doing. That they can really improve upon themselves as they start early, and try to see way ahead what they want, and their goals, and try to steer toward that. And I think that I can help kids do that and I realize the importance of that. (I. I.)

Gary placed a high value on the teacher being able to relate to students and making the content relevant to students lives. For example, when he was asked what type of location in which he would like to teach, Gary said he would choose a moderate sized rural town because,

> "See, I could relate best with the students. You know where at least if you wanted to talk, about, in the subject of biology, (something) like population dynamics or control of a wildlife species, you know, that maybe, some of the kids at least have hunted or know something about it where you can relate it." (I. I.)

Gary believed the learning outcomes for a science class were to include much more than the propositional science knowledge presented as basics. Instead, procedural and dispositional knowledge of science, and other aspects, such as career or vocational education were all aspects of teaching students about life skills through the content area of science. The teacher's role was to be a human potential developer and learning facilitator, or a learning developer.

Gary's thoughts about how an ideal teacher functioned in this role were derived from his responses to the question about what he would be most concerned with in science instruction. Gary said,

> "Well, definitely that they are learning the material (content), and I think the best way to learn a lot of times in biology is by participating in some type of a project. Where you are not just reading out of a book, but can actually relate to things. Like, for some reason I always keep coming to where you are dissecting an animal, or something, and you are studying the organs where you see them. Of course, biology is so wide like plant biology, or whatever, so you could always have a project like that where you can study things in a hands-on situation. Biology is a lot of memorization, but I definitely want, it would be easy for me to stress, what's really important, like you know you dissect it so far, and later on in college then you dissect that further yet, and that sort of stuff, you at least get the basics. Where they are familarized with some of the cycles, and what not, that is going on around them, and things in the cycle, and make sure they can relate that back to you on a test, and then get into the practical part of it so that, actually, they've had the hands-on part of what you have been teaching them, and then they can kind of see, and

> help relate to the all important other, things and ask questions. And to me then they can see the importance of why they need to know the stuff and why they ought to know a cycle better in the future and things like that." (I. I.)

Gary believed the role of the teacher was to teach students the basics of science knowledge, but also to make it relevant to student lives. He believed students should learn by experience with hands-on activities, along with memorizing and then applying what they've learned. The way a teacher could encourage this was explained as follows:

> "I don't think it would be a lot of lecture. At least for me I think it would be a lot of questions back and forth, and at least for me in high school, I would try to assign some reading, and next time discuss it. Cover the main points, and then give them something to do in class to try to apply, and then go around and try to help them. Biology class just seems like it would have be that. To be involved, either with questions back and forth, or you know, you'll have to do some discussion and what not. Maybe a lot of pamphlets, or handouts, to clarify things, especially if you are talking about anatomy and morphology, or something like that, so that you can relate things, and get a clear picture across.
>
> So I think, after initially starting the class with reviewing, what you have got to do, from that point, is to decide what is important as far as making sure that they know. It seems like it starts out with lecture to cover the main points, and make sure they have got something, and then trying to apply it." (I. I.)

In summary, Gary's defined role for the teacher was a complex interaction of multiple roles, which included student career counselor, presentor of scientific content, designer of application or hands-on experiences, and environment coordinator. He believed that ideally a teacher was a learning developer, who provided students with scientific knowledge in a context that made it relevant to their lives through a wide variety of activities in instruction.

<u>A Role for Students</u>: Gary believed a teacher needed to account for differing student learning style when designing and implementing instruction. Students learned best if the content was relevant and related to their lives. Gary was asked what problems he thought students would have in learning science, and what he would try to do as a teacher to make it easier for students. He said:

> "Well, I think it is like math with girls. I think a lot of it is just in their heads. It is so applicable to everything you do. I think you can find instances, constantly, where you can show people that they use biology everyday, that they know a lot already, and just going on to. What I would do (is) to try to show the kids how it can be important in the future, and be excited about it. And if, I guess, I think, I could make biology seem important whether, or not, if you were going on to study it, and do research, or whether you were just going to live casually, and not realize what is going on the rest of your life. As far as being difficult it just seems, I can't imagine it. Of course, it was easier for me than a lot of things. But I can see where kids could be turned off. I just think it ties in with the rest of a successful class. If you can be enthused about it, then people start to lose their fear of it. Especially, if you keep giving them hand-on time on certain things so that they can become more familiar with it. Maybe it is a lack of appreciation, because they just haven't been involved directly with it. So I think if you can do something directly like that it is possible it will work to help them." (I. I.)

Gary believed students as learners were not all alike, and it was essential to have students actively involved in hands-on, and application activities so that they became familiar with science. Thus, the role of the students was to learn dispositional, propositional and procedural science knowledge by being active determiners on both mental and physical levels in science instruction.

The students were determiners because the past experiences they brought to the classroom influenced the teacher's decisions about how content should be presented, as well as when, or the pacing of instruction during a lesson or sequence of lessons. Students did not, however, directly influence the teacher's decisions about what should be taught.

The Idealized Picture of Teaching

Gary believed it was more important to have meaningful learning occurring in the classroom, i.e., learning which was directly relevant to the students own lives, than to cover the "basics" required in a course curriculum. In other words, students may not be exposed to all the science content prescribed for the course, but they would understand, appreciate, and be able to apply the content that was covered in his course.

The picture of Gary's classroom is one in which there would typically be a high degree of student mental and physical involvement in learning science. A wide variety of purposeful activities would be used, and individuals would be continuously assessed for problems they may encounter in learning new content.

The role of the teacher would be that of a learning developer who designed instruction, which included many applications of the content to make learning meaningful for students. When it came to curriculum development, the teacher and the school system's educational leaders would determine what science would be taught. The students' role would be that of mentally and physically active determiners. Students' background and mental conditions influenced the teacher's decisions about how and when new scientific knowledge content was presented. However, since the teacher would decide the details of what scientific knowlege content should be taught without consideration of students' mental condition there may be reinforcement of misconceptions or a lack of learning as unintended results. Thus, a high degree of learning would not be assured by Gary's ideals for teaching.

The Realistic View of Teaching

Clinical Interview Data Source

Essential Elements of a Lesson: Gary was asked to imagine himself in the classroom with a group of students who were about to leave the room at the end of a class period. He was asked to describe how he would know if the lesson or series of lessons he just finished teaching were successful or not. He said,

> "I think basically in my own regard, I think it is how enthusiastic the kids ended up. And sort of whether or not you get any feedback as to whether this was really interesting, you know, and would I recommend that they thought about presenting something in that field where their interests were at that time. Unless I get somebody doing that, I would think I had kind of failed, because I really think that if you can't be excited in biology, which is really life you know, then you

really failed. This is why I say if you get right down, and just start preaching the stuff, and these cycles, and you wear kids out, and you don't really relate it to anything to show the importance of it, then I think you have failed. So I think the sequence is almost irrelevant as far as if they have to learn so many prerequisites, or what not and you do have to learn the basics of all this stuff. And as long as you do keep it contiguous, or whatever, so that they can relate to it and you can move on. But just constantly, I guess, just keep showing them that the farther you go on, you just keep reaching a little farther and showing them things that it is opening the door for. So, if kids didn't ask a lot of questions, or come up with a lot of different things, I'd think I wasn't on the right track or I wasn't doing a good job." (I. I.)

Realistically, Gary thought it was more important to teach whatever science content was presented in a meaningful manner, i.e. to the point where students understood it in relation to their lives, than to make sure all the defined basics for a course were covered during class time. Gary's defined goal for teaching was to have students understand content at the application level. He defined a teacher as one who needed to be responsive to students and flexible with the pacing of science content. Success of his teaching was defined by what occurred within a daily lesson teaching situation rather than how much content was taught.

The individual students provided Gary with feedback about the lesson and were considered the determiners of the success of his teaching. The teacher was responsible for presenting science content in a manner which enthused students sufficiently to make them want to learn more content. The teacher was a facilitator for this self-learning process through such things as individual projects. The teacher also assessed students to make sure learning was occurring.

However, Gary did not express a concept that the teacher needed to assess the specific mental condition of students in relation to specific scienctific knowledge content he would teach in his definition of successful instruction.

When probed for how he would specifically teach, Gary stated,

> "I think after initially starting the class with reviewing, what you have got to do from that point is then, also trying to decide what is important as far as making sure that they know. It seems like it starts out with lecture to cover the main points and make sure they have got something and then trying to apply it." (I. I.)

Gary's essential elements of a lesson, were: 1) a lesson set, 2) presentation of new content, 3) practice with feedback to students, and 4) reviewing, or some form of 5) extension activity for continuity. His use and meanings encompassed several factors or variables associated with each element.

The lesson set was an activity to assess students' background for use in deciding how to present new content in a way which was meaningful to the students. It was not used to assess students' mental conditions or for identifying potential problems students may have in learning the specific scientific content. The choice of new science content presented in the lesson was a teacher decision which was not directly influenced by students' mental conditions. Rather, new science content presented was identified by the teacher in conjunction with the educational system goals for science and his own personal knowledge of science. Application and practice with feedback activities were intended to make the science content meaningful and stimulating enough to involve the students directly in the lesson. The summary was a means of providing students with more relevancy for what they were asked to learn and to show how it all fits together.

The role of the teacher was defined as a learning developer, or one who uses students' personal background as a base for presenting scientific content in a meaningful manner and to provide them with a reason to learn. The role of the students was that of mentally active determiners. Students' past experiences and general knowledge were important considerations in the teacher's decision about how to best present content. These were not direct determiners of what specific science content details should be presented for a lesson to ensure a high degree of student learning outcomes.

<u>Essential Frames of Planning</u>: Gary was asked to describe how he would get ready to teach a lesson if he were a biology teacher. He said,

> "I think definitely, each day I'd like to go in with some type of a question, and stimulate some thought, or hit upon an area that the kids hadn't thought of and then just leave it. Just say, you know, remember this and remember that and do this and take this and eventually you bring in this field over here and point out this is what you could do, or this is what you could be, or this is what's happening. You know, because people right now know this is what you are learning and they applied a little bit more and took another field to it, and now this is what is happening. You know, like cytogenetics, or something on that order. Just hit them with it and then leave it. And get back to what you want them to learn that day. And I'd have a definite set of objectives for what I want them to learn that day. What we discussed earlier. And tell them what it was going to lead to; why we are doing it. Of course, they'll have the general outline of the course anyway, but just to say why this is necessary. And then start in asking a few important questions and get the feedback and that sort of thing. My

> lesson plan probably, I guess, would try to follow the objectives that I have given the kids pretty much. Have a chance then, after I have presented what I want them to know, or I don't even know if they take notes in high school anymore. But basically study it and then have some type of an activity that they can do to practice what I just taught them. Of course, I don't know exactly what I am going to be doing, but so that they can, during that class time work on something for a few minutes so that I can go around again, and find out where the hang ups are, and on a daily thing see how people are coming. Whether or not they are really lost whether or not it's going too slow for them, who's having problems and who is getting right along. And then at the end I would tell them where I thought they were more or less. And then whether it was good, or bad, what progress was going to be the next day, and give another assignment for the next day and go over that." (I. I.)

Gary's response indicated that in daily planning he would make decisions related to each of the following frames: 1) objectives, 2) learning outcomes, 3) activities, 4) assessment (ind.& group), 5) time (pacing), 6) sequence of content (continuity), 7) teaching strategy, and, 8) management of student behavior. The only frame Gary did not refer to was management of materials.

In planning, Gary had a complex procedure, which interrelated different frames to answer specific questions he had related to the essential elements of a lesson he defined. The meaning given to frames was directly related to their functional use in the answering of his questions. Activities were selected based on their ability to contribute to objectives for the lesson, student learning outcomes, and assessment of learning, in his defined teaching strategy. Assessment was something which occurred continuously within the lesson, but it had only an end result focus. In other words, after the new content was presented to students, checks were made on individuals and the group about the learning situation, and the students' mental conditions, in relation to the new content. This post-assessment of content was linked to the pacing and the delivery of a sequence of content. Therefore, time was given a meaning strictly limited to content pacing.

Learning outcomes were directly related to objectives, and they encompassed more than just propositional or factual science content knowledge. Gary wanted students to be able to relate to, and apply, scienctific knowledge, which implies that procedural and dispostional scienctific knowledge were also considered as desirable learning outcomes in science teaching. However, it is questionable whether or not Gary actually defined objectives for these knowledge types based on his response. Management of student behavior was implied by his desire to monitor and assess students learning problems on an individual basis. This implied that his management of student behavior decisions were focused on a concern for mental condition, rather than a discipline or behavioral concerns focus.

Gary's implied role of the teacher in these planning frames was that of a learner developer. That is, his task as teacher was to use information about his students lives and past experiences to present new science content to them in a meaningful way. New content was not only related to students' lives, but also practiced in activities requiring a mental engagement with the content to the extent that they could apply it successfully on an individual basis. With regard to a conceptual change orientation to teaching, the only major difference was that Gary failed to account for students' entry to the lesson with specific mental conditions relating to the new science content of a lesson. Gary operated out of a concept that students' mental conditions influenced how and when he would present science content, but this did not influence decisions about what the daily lesson content details should be included.

The role of the students was that of mentally active determiners. The students were viewed as individual learners with differing needs and influencers in the teachers' decisions about how and when science content should be presented. They were mentally and physically engaged in the instructional activities, and were to learn not only the basic propositional knowledge related to science, but also procedural and dispositional knowledge as learning outcomes in a science lesson.

Plan and Recall Data Source

Essential Elements of a Lesson: Gary was asked to describe how he imagined his planned microteaching inquiry science lesson would occur. He said,

> "O.K., I was just going to ask them (students) to have a seat. Then I was going to sit down as well. Of course the objectives, I thought would already be on the board, but then I'd just introduce myself..(goes through details of activity)..then everybody could tell me something in that regard.
>
> Then I might ask, 'Well does anybody know anything about electricity?' And if someone does I'd say, 'Fine.' and if not I'd say, 'Well that's good everyone is starting from the same

ground, or something like that and it's what we'e going to talk about today.

Then I was going to start a lecture. I was going to state the objectives and introduce them to the idea of a circuit and circuitry. I was going to tell them, describe a battery as the energy source, and then the conductor as the wires that would complete the circuit, and give them an analogy of it to the water lines or whatever...(continues through lecture notes discussion)... I might talk to them a little bit about how in certain situations that it (electricity) will actual flow the other way, but I don't think I will unless they ask too many questions, and I think I can get out of it pretty simply, just by generalizing.

Then I'd like to have them spend time with the materials. O.K. I'd introduce them to drawing the diagram. I'd have to do that as well as tell them just a little bit about drawing them after one time of experimenting. Then I'd let them go ahead and if they find a circuit that works to try to diagram it on their paper...

Then I'd give them the materials, at that time, and just let them start experimenting and kind of stand back and observe. I imagined that would go on for about ten minutes, or so, and kind of encourage some kind of thought. It depends on how fast they go with it. If one group goes faster than the other ones, or something, I'd encourage them to help the other ones or something. And if they get done relatively quickly, then progress to something else, like I only had one battery, so I put another battery in as well, so maybe I could tell them to connect two batteries together, or ask them what they could do with two batteries, or maybe I could have them finish up the amount of time with that.

Then I'd give them the handout (Teacher's Guide Worksheet), and have them actually draw for me the diagrams, or identify ones that will work. And the kind of wrap it up from there. Maybe again tell them some way that they can relate this, or go home tonight and describe to their folks something about how a flashlight works, or something on that order." (I. P. R.)

Gary's description was very detailed. He accounted for multiple variables which may affect what could occur and had alternative teaching strategies in mind to address these if needed. He anticipated differing responses to activities and accounted for these in his planning procedures.

In Gary's presented response the essential elements of a lesson included were: 1) a lesson set, 2) presentation of new content, 3) students' practice with feedback, 4) a summary, and 5) an extension activitiy. However, some of these elements had questionable meanings.

The questionable aspect of the lesson set was the use of such a broad general topic question as the mechanism for preassessing of students' mental condition related to lesson objectives, and new science content. Gary did not see the need to modify lesson content objectives as a result of the preassessment of students' mental conditions. The second aspect of the lesson set, presenting the objectives to the students, established a direction and goal or mental set in students about the science content, and the subsequent activities.

Gary defined the role of the teacher in his description of the essential elements of the lesson as that of a learning developer. The teacher was one who assessed students' mental conditions in relation to new content and used the resultant information as an important factor in decisions made about how and when new science content was presented in a lesson. This teacher did not use the information to decide what new scientific content should be presented.

The role of the students was that of mentally active determiners. Students were to be mentally and physically involved in a variety of activities, the purpose of which was to develop learning outcomes. Students' mental conditions and responses influenced how activities would be done, but did not influence what details of science content would be presented.

The Essential Frames of Planning: When asked to explain the thoughts he had as he formulated his lesson plan for the microlesson on batteries and bulbs, Gary's elaborate description of how he imagined his lesson would occur was essentially repeated with even more details present than when he was asked to describe what he had initially thought his lesson would be like,

> "Well, first I tried to visualize what would occur in the classroom. So actually, like I just met the kids, so then I just basically started out with an introduction between the two of us. Just a little information about what they were interested in, and then described what we were going to talk about in the class and then I decided I'd better start writing and that's when I started getting to my objectives. So, I wrote the personal goal for myself and then what I thought were the objectives.
>
> I wrote down objectives, because that's what I'll have on the board, hopefully, before the kids even come to class, so they will know specifically what we are going to do. And then if I ever have to remind them, I can just go the board and tell them. So then I had trouble writing the objectives for some reason. And then, I finally started getting more than I wanted, at any rate it is difficult to because I have to write objectives to try to interlock this program or lesson with what my partner is going to do, so that kind of created a little bit of a problem. But then, putting the objectives in the right terminology and that sort of thing. For some reason, I just got hung up but it's you know, I don't anticipate that problem too much in the future. At any rate, I went back and reviewed some of my TE 200 notes as far as the organization of a lesson plan and got some ideas from that. Then after knowing what I'd teach them, I kind of in my mind just started talking to the kids as to find out where any hang-ups might come in, explaining the circuitry.

So that was the fundamental thing to me, to explain a circuit. The difference between an open and closed circuit, and if you introduce the light and try to show them the concept of energy flow. And then I just, by talking to myself, came up with the analogy of, and I researched in my physics book and things like that too. And in there they describe electricity as a flow, like water in pipes. So I decided to use that analogy in my lecture.

And then I thought afterwards that I'd give them that much information on circuitry. Then I figured I would introduce the materials and then let them experiment on their own with the things that I'd given to them. And with the objectives written on the board that they should be able to make the light work by at least a couple of different circuiting pathways.

Then I suppose I was worried about how they were going to sit at the table and who was going to work. I supposed I would have two pairs with four people. And the pairs set across from each other for maximum interaction. And then just pretty much leave them on their own and if they ask questions don't give them a direct answer, but some sort of stimulating question that they would have to continue to think about themselves. I suppose if toward the end, when I see they've progressed and some amazing things happen, I'd also try to instruct them or to let them know about the data. I think I kind of included that in my objectives. To draw diagrams of the ones that work and don't work. So when they do find a system that works then to go ahead and try to diagram it. And then I'd show them examples on the board of diagrams and how to do it. And then when I've seen that they've progressed to the point where they can make the light work and I don't think I'll introduce the motor. I'll maybe leave that for my partner. I'm not sure we'll have to talk about that today. Uhm, but then go ahead and give them the handouts and ask them to identify circuits that will light the bulb and those that won't. And that will provide some kind of feedback to me to see that they have learned what I wanted them to. And then kind of wrap it up and maybe associate the whole business with how a flashlight works. I may have done that earlier in the lecture. So that they will have some kind of an impedance (impetus) to go ahead and learn it and figure it out because then they can relate it to something afterwards." (I. P. R.)

One important addition to these data, was that Gary used the science materials himself to try out activities suggested in the teacher's guide to understand how they worked, what problems might occur, and what could be taught as he began his planning for the lesson.

Gary's decisions, as he formulated his lesson, included all nine planning frames: 1) time, 2) management of student behavior, 3) management of materials, 4) objectives, 5) learning outcomes, 6)assessment, 7) activities, 8) teaching strategy, 9) sequence of content. Gary used a complex procedure in planning, and addressed frames in related groupings as he made decisions about his defined essential elements of a lesson. He thought about numerous responses students may have to activities and had clearly established alternatives for dealing with potential situations that he anticipated for the lesson.

His presentation of the role for the teacher was one who was flexible and realized that individual students have differing learning needs. He accounted for these in his instructional strategy. He had a variety of ways to address learning needs on an individual basis and a group basis. He clearly wanted students to learn more than science facts, and to be mentally and physically engaged in the activities. His role was to structure and develop experiences, which accounted for students' mental conditions in relation to how a lesson was planned and how instruction was implemented. However, Gary did not assess or account for students' specific mental conditions in relation to establishing or modifying objectives for the lesson, or in deciding what content should be presented in a lesson. Thus, the teacher's role was to be a learning developer. The students' role was that of active determiners in instruction derived from their general mental condition in relation to the science content and desired learning outcomes of the lesson.

Microteaching Lesson Data Sources

Lesson Summary (For a detailed account of teacher and student actions in the lesson, see Appendix B.): Gary began his lesson by asking the students if they had experience with electricity. One student did, so he probed for what kind of experience the student had. He then assigned the students to groups for lab work, based on the students' responses to his questions, and proceeded to give the students the general objective for the lesson.

From the presentation of objectives, Gary moved on to a teacher-led questioning session to develop new content. Within this context, Gary gave a minilecture using the chalk board to diagram and explain the materials and concepts about circuits which students did not know or were unsure about. He explained energy, battery circuits, and open and closed circuits. In his explanation, he used an analogy of a water pump and pipes to explain open and closed circuits.

The minilecture was followed by convergent and divergent application questions, which assessed students' understanding.

Students were then given directions to use the materials to build circuits in several different ways. They began immediately with Gary helping those who needed assistance to get started. He then monitored the students by asking questions of individuals, or answering inquiries.

Once a group succeeded in getting a completed circuit he had them share this with the other students. The successful students explained their circuit. Gary then gave students a lab worksheet to be completed. At the end of this lab activity, students were given an electric motor on which to try in their circuits. This was a time when they were reminded about mechanical and light energy.

The lesson summary was another application situation with a flashlight. First a student was asked to demonstrate open or closed circuits with a flashlight. Then all students were asked to join hands and form a circle to illustrate a "closed circuit". An "open circuit" was demonstrated when some hands were not joined.

Essential Elements of the Lesson: Gary's lesson had the essential elements of, 1) lesson set, 2) presentation of new content, 3) practice with feedback, and 4) summary. Gary's manner for presenting new content was to provide most at the beginning, with practice and assessment prior to introducing additional new content throughout the remainder of his lesson. As students practiced new content in activities, Gary provide them feedback. At the end of the lesson two brief summary application activities were done with the students.

The teacher's role was to develop an applied, practical sense of the science content. The teacher was a learning developer who used student responses as essential factors in the decisions of how and when the next new science content would be presented in the lesson. The teacher was flexible and responsive to the students, and maintained a very high level of student mental and physical engagement throughout the lesson. Students demonstrated their understanding of what they were taught at an application level. Hence, the role for the students was that of mentally and physically active determiners. Teaching was viewed as a complex task and learning was a complex process. In twenty-five minutes, the students learned ten new concepts which were interrelated, summarized, and presented with practice in multiple ways.

Essential Frames for Planning: Gary's lesson had minimal behavioral problems or time off task during the lesson transitions. The planning process provided him with a mental set for making decisions in a flexible manner. There was evidence that appropriate decisions which involved multiple variables had been made in relation to all nine planning frames. From the structure of the lesson, Gary's planning procedures were inferred to be complex. Each activity, or essential element, had different groupings of frames about which Gary had made decisions. For example, in the lesson set episode, students were given objectives as desired learning outcomes and told how they would work in lab groups to do experiments in relation to learning the objectives. Gary had addressed the frames of 1) teaching strategy, 2) objectives, 3) learning outcomes of both a propositional and procedural nature of science, 4) time as pacing of content for students, 5) activities selected on the basis of their contribution to learning the objectives, 6) management of student behavior, 7) management of materials as no materials were out for students to play with, 8) sequencing of content, and 9) assessment as to find out what previous experiences students had, and what specific knowledge they had about circuits.

Although Gary assessed students for their understanding of electrical circuits as he did the lesson set, the actual defined role of the teacher was that of a learning developer. He subsequently used only the feedback to determine how and when new content would be presented with no clear indications that what was presented as new content was influenced by students' entry mental conditions about the lesson objectives. The teacher responded with flexibility to the students by instructional pacing and by continuous pre-instruction and post-instructional assessment. Individual needs in relation to learning the content were accounted for by having different students assume subroles. An example was to have one student who had prior experience with electrical circuits serve as the teacher's assistant for a content application problem solving tasks. Learning was seen as a developmental process that occured within the individual through practice in applying knowledge in a variety of situations.

Summary Essential Elements of a Lesson Data Source Comparison (See Figure 4.5)

Gary addressed the essential elements of 1) lesson set, 2) new content presentation, 3) practice with feedback, and 4) summary for the lesson as described in all three data sources. The meanings of the summary in the clinical interview data and the inclusion of an extension activity in the planning recall data were the only two discrepancies across data sources. The meanings given to the essential elements consistently defined the teacher's role as a learning developer and the students' role as mentally active determiners. Teaching was viewed as a complex task which required the teacher to be flexible and responsive to individual students, and group needs, on both a physical and mental level. It involved a high degree of quality interactions, such as using divergent questions and applications to ensure that students acquired an understanding of content.

Summary Essential Frames of Planning Data Comparison (See Figure 4.6)

There was little difference across the data sources in relation to the number of frames Gary presented as essential for effectively planning a lesson. He demonstrated a cognitive consistency in the meanings given under all three data collection procedures. The roles defined for the teacher and for students were, respectively, learning developer and mentally active determiners. Planning was a complex process, interrelating multiple variables within each frame. He used

Figure 4.5 Essential Elements of a Lesson - Gary

Data Source	Clinical Interview	Plan and Recall	MicroLesson
Essential Elements	Lesson Set New Content Presentation Practice with Feedback ? Summary	Lesson Set New Content Presentation Practice with Feedback Summary Extension Activity	Lesson Set New Content Presentation Practice with Feedback Summary Extension Activity
Teaching Strategy	Variety & Flexible Way for Lesson	Variety & Flexible Ways for Lesson	Variety & Flexible With 12 activities done 6 key objectives
Teacher's Role	Learning Developer	Learning Developer	Learning Developer
Students' Role	Mentally Active Determiners	Mentally Active Determiners	Mentally Active Determiners

? Questionable meaning and use by subject

Figure 4.6 Essential Frames in Planning a Lesson

Data Source	Clinical Interview	Plan and Recall	MicroLesson
Planning Frames Used	Activities Assessment Sequence of Content Objectives Learning Outcomes Time (pacing) Teaching Strategy Management of Student Behavior	Activities Assessment Sequence of Content Objectives Learning Outcomes Time (pacing) Teaching Strategy Management of Student Behavior Management of Materials	Activities Assessment Sequence of Content Objectives Learning Outcomes Time (pacing) Teaching Strategy Management of Student Behavior Management of Materials
Frame #	8	7	9
Ed Goals	* Science P.P.D + Life Skills	* Science P.P.D + Life Skills	Science P.P.D. + Life Skills
Teacher's Role	Learning Developer	Learning Developer	Learning Developer
Students' Role	Mentally Active Determiners	Mentally Active Determiners	Mentally Active Determiners

* Scientific propositional, procedural, and dispositional knowledge

the frames to answer specific questions related to the essential elements of a lesson and to formulate his plan for a lesson.

The Realistic Picture

Gary's microteaching lesson defined a picture where students typically are highly involved, both mentally and physically in purposeful learning activites. There is a high degree of interaction between the teacher and students and student with student, about the content of the lesson. Students are given a purpose and structure for completing activities. The teacher maintained a high degree of on task learning behavior by identifying and solving problems. The key flaw in the situation was that students did not always acquire the appropriate scientific explanation for events in a real world situation as a result of the learning process. This was due to the teacher's failure to account for specific entry mental conditions about science content that individual students had and used to interpret instruction. Hence, in Gary's classroom, students inappropriate scientific explanations for events may be unknowingly reinforced by instruction rather than corrected by instruction.

The teacher's role in Gary's classroom is that of a learning developer, with multiple complex interactions of variables about students, content, and teacher accounted for in decision making about the design and implementation of instruction. The students' role is to be mentally active determiners who influence both how and when something is taught, but do not influence what was to be taught.

Determinants of the Curriculum

Gary viewed instructing students, or classroom teaching as a relatively complex task as he began the methods course. He seemed to, however, view the designing of instruction, or planning task of a teacher as something relatively simple with the curriculum being dictated, for the most part, to a teacher by others in leadership roles in the educational system. To explore Gary's long range planning for a course he was asked to tell what he would do to prepare to teach if he were hired in August. He said,

> "I would definitely ask to see the book first. I would like to see what the school emphasized. What they definitely want taught, and the leeway I would have in emphasizing different aspect of it.
>
> I thought that I could probably talk to the principal or someone. And if not, other biology teachers or the other teachers somehow. Of course, if they give you the book you can follow it, but I don't even know, because like in college you don't even get throught the whole book a lot of times. And whether or not there is something current. Like I say, there is only so much time, and to me it is better to familiarize the students to a lot of things that are the basics. Show the basics and consequently their (students) options. So I'd get the text, I'd see what kind of progression the text followed so that I would know just about basically what they had had, and then I'd ask the principal, or what not, what they want emphasized, or what they had been lax on where they want improvement. Then I would discuss, with him, my strong points, and what I think might be important for the course, and see how that went over, and then I'd probably try to talk him into some field trips, and see what was allowed, so that I could plan accordingly to that. Of course then I'd have to discuss what kinds of material I'd need, and make sure I had those ready. And then I'd probably start concentrating on getting a lot of handouts, and what not, prepared that would help me instruct the course where it might be tough going, or difficult, for the student to give them an aid. And to help out, I suppose also then I'd figure out where the kids were coming from, what they last learned and what they should know by the time we're through, so that we keep things tied together a little bit. Other than that I guess I don't

know." (I. I.)

Gary believed that the school system posed some limiting factors which may not allow him to do what he believed was important in a course of instruction. His first concerns in planning the curriculum was the collection of information he needed for decision making. The information areas that Gary wanted specific knowledge about included the system expectations in relation to content covered, textbook and resources for teaching activities and teaching aids, and knowledge about the students. He wanted to know what the general science knowledge mental condition of his students would be in relation to the science content he would teach. These determinants of curriculum were the students' mental condition in relation to content, system-defined limitations and expectations for his teaching, resources available for teaching, and his own knowledge about scientific knowledge and collection of activities for teaching this to student he brought with him.

Summary of Gary's Conceptions of Teaching Patterns

Gary entered the methods course with a complex view of the nature of teaching. His defined problem for course interpretation was to learn how a teacher thinks and acts within the confines of a particular school system in an effective manner in order to help students learn. In other words, Gary believed the system imposed boundaries on a teacher that would, he feared, prevent him from teaching students in the way he believed was effective. In determining a curriculum for a course, knowledge about the system limits was the first decision making information he felt he needed.

In addition to the system, other situation specific determinants of the curriculum were: the teaching resources he had available to him; the students' general mental condition in relation to the content; and his own knowledge about science and science teaching activities.

Gary was able to operationalize his ideals of teaching with the propositional and procedural knowledge of teaching he brought to the course, as defined in this study. He had a great deal of cognitive consistency between his dispositional, propositional and procedural knowledge base about teaching. This mental framework for teaching defined similar idealized and realistic views of teaching. Hence, his teacher's learning developer role with students as active determiners had only one significant discrepency between his knowledge base of teaching and that of a conceptual change facilitator teacher. He failed to account for students' mental conditions as they related to specific science content in the process of deciding what should be taught in a daily lesson or series of lessons.

Summary of Data Sources for Conceptual Patterns Determination

Gary presented a state of great cognitive consistency across all data sources for all three types of knowledge. The clinical interview was the most limited for defining the essential elements of a lesson or the planning frames. However, the absence of one planning frame in the clinical interview data along with a questionable meaning for one essential element in the plan and recall data source, did not define different teacher or students' roles in relation to the microlesson data source.

Cognitive consistency existed within Gary's mental framework for teaching. There was little difference in the patterns which were determined based on data sources in which Gary talked about teaching, or did a noninstructional planning task, or in actual instruction in a microteaching situation.

Comparative Summary and Dicsussion of Conception Patterns for Case Study Subjects' and the Expert.

John, Ray, and Gary were representative of the subjects of this study in their commitments to teaching, rationale for becoming teachers, and science majors. They were each at approximately the same point in their course sequence for becoming certified teachers; that is they had completed the prerequisitic educational psychology introduction to teaching course, and were taking a general methods course concurrently with the science methods course associated with this study. In addition, their articulated thoughts in the clinical interviews were representative of other subjects' responses to the questions developed around Schwab's (1969) four commonplaces of teaching. In data analysis, their responses evidenced a range of conceptual patterns for the central developmental directions which emerged in relation to those of the effective teacher as presented by Dr. K..

The following comparative discussion addresses each of the key issues which emerged during data analysis as presented in the case studies. Each issue first identifies the specific data used to define the conceptual pattern. Then the conceptual pattern of the effective teacher is presented as a basis for contrast and comparison of the conceptual patterns of the three subjects. A discussion follows describing these differences in reference to what the subjects' learned from the methods course and to their ideas of becoming an effective teacher. The findings presented in Part II of this chapter are based on the range of categories defined for each issue by the case study subjects and the expert.

To facilitate comparison, the issues are presented in the same order as in the individual case studies. The nature of a teacher's work and problem for course interpretation are first. Next the idealized and realistic views of teaching are presented. This is then followed by the determinants of the curriculum issue, with a concluding discussion about the subjects' potential for becoming an effective teacher. Conceptual patterns are summarized in figure 4.7.

The Nature of a Teacher's Work

A simple or complex conceptual pattern about the nature of the work of a teacher was derived from a subject's articulated rationale for choosing a teaching career, and thoughts about the degree to which they believed they were prepared to teach as they began the methods course. Dr. K, as an expert believed that teaching was a complex, multifacited task which involved complex subtasks of designing instruction, and implementing instruction. Decisions made by a teacher, in completing either task, required consideration of multiple specific variables about students, scientific knowledge content, and teaching strategies, which encompassed the commonplaces of the teacher and the milieu (Anderson & Smith, 1985).

Gary, like Dr. K, believed teaching was a complex task. However, unlike Dr. K, it was only the instructional aspect of the work which was

Figure 4.7 Comparative Summary of Conceptual Patterns Related to Key Issues for Case Study Subjects and the Expert

Issue		John	Ray	Gary	Dr. K.
Nature of Teacher's Work		Simple - presenting content	Simple - translating and presenting content	Complex - Students Teacher Curriculum Milieu	Complex - Students Teacher Curriculum Milieu
Problem for Course Interpretation		What is it like to be a secondary science teacher? (Career Choice)	How am I supposed to act to be an effective teacher? (Prescription for teaching)	How can I think and act effectively in a school system? (System Constraints)	How do effective teachers think and act?
Idealized View of Teaching	Teacher's Role	Learning Facilitator and Assessor	Learning Facilitator	Learning Developer	Conceptual Change Creator
	Student's Role	Physically Active Responders (homogeneous)	Mentally Active Responders (heterogeneous)	Mentally + Physically Active Determiners (heterogeneous)	Proactive Determiner (heterogeneous)
Goals		Scientific Propositional Knowledge	Scientific Propositional Knowledge	Scientific Propositional Procedural, Dispositional Knowledge + Life Skills	Scientific Propositional Procedural, Dispositional Knowledge (thinking)
Realistic View of Teaching	Teacher's Role	Content Authority Presentor / Content Authority + Activity Director	Learning Instiller + Learning Assessor / Content Authority Presentor + Assessor	Learning Developer	Conceptual Change Developer
Student's Role		Physically + Mentally Passive / Physically Passive Determiners	Physically Active Responders / Mentally + Physically Passive	Mentally + Physically Active Determiners (heterogeneous)	Proactive Determiners (heterogenous)
Goals		Scientific Propositional Knowledge / ?? No Learning	Scientific Propositional Knowledge	Scientific Propositional Procedural, Dispositional Knowledge + Life Skills	Scientific Propositional Procedural, Dispositional Knowledge (thinking)
Determinants of the Curriculum	Situation	1. Textbook (Defines)	1. Textbook (Resource)	1. Student General background 2. Teaching Resources 3. System Expectations	1. Student General Ability 2. Teaching Resources
	Teacher	1. Science Knowledge Base 2. Collection of Teaching Activities for Science	1. Science Knowledge Base 2. Collection of Teaching Activities for Science	1. Science Knowledge Base 2. Collection of Teaching Activities for Science	1. Science Knowledge Base 2. Collection of Teaching Activities for Science
Potential for Course		Very Limited	Great	Limited	
Learning from Classroom Experience		Not Likely & Long Range Only	Limited	Great Immediately, Daily	

seen as complex. The planning task was simple to Gary; he believed the leaders of the educational system would tell him what he had to teach, and all he needed to do was to determine how and when scientific knowledge content would be taught.

Unlike Gary or Dr. K, both John and Ray viewed teaching as a simple task. Ray's conceptual pattern was more detailed than John's, because it encompassed beliefs that the teacher needed to translate content for appropriate instruction to occur. He addressed both the student and the curriculum commonplaces in his concept pattern. John, on the other hand, believed the nature of the work was to simply present scientific knowledge content to students. John's simple view of teaching only encompassed the factor of content in relation to the nature of teaching, while Gary and Dr. K each addressed students, teacher, content and milieu.

The relevance of the commonplaces for effective and efficient functioning as a teacher may be likened to the web a spider spins. The functioning of the web is totally dependent on factors of how many anchoring points are used and where these are located in the environment. Gary's anchoring points built an elaborate web, like Dr. K's, but the efficiency is questionable because of where one of the anchoring points was located: in that Gary believes that "what is taught" is decided by someone in the school system other than the teacher. Ray's web had only the two anchoring points: students and curriculum. John had one point, curriculum anchoring point for his web.

Both were very limited and defined a web in which effectiveness was questionable to such an extent that efficiency was immaterial. Gary, Ray and John were at very different points concerning a foundational knowledge base about teaching and for learning how to do it effectively either from course experiences or in actual classroom experiences.

The Problems For Course Interpretation

Responses to questions related to what a subject wanted to learn from the course experiences, and how well prepared they felt to teach resulted in a definition of a problem each individual wanted to solve during the course. Dr. K. designed the course to solve the problem of how an effective secondary science teacher thinks and acts, with specific course experiences designed to teach this knowledge to preservice teachers. Dr. K. believed effective science teaching involved the development of procedural, propositional, and dispositional knowledge in students.

Gary and Ray each entered the course with very specific goals in relation to becoming effective biology teachers. John did not have a specific idea about what he would teach. In fact, he believed he could teach anything if he "put his mind to it". The problems each wanted to solve through the course experiences were reflected very differently in relation to their projected self-images of self as teachers.

John wanted to find out what secondary science teaching was like, to see if he really wanted a career as one. He was not particularly concerned about the specifics of how an effective teacher thinks or acts. He wanted general knowledge about the work tasks and demands of secondary science teaching. His concern was about himself as a teacher. He had a career choice problem to solve.

Ray clearly wanted to learn how to act like a teacher. In fact, Ray was looking for specific prescriptions for teaching which would enable him to translate and deliver content to students which would involve and interest students in learning scientific propositional knowledge.

Gary, on the other hand, believed he had a good idea of how an effective teacher thought and acted and was most concerned about how the system might prevent him from functioning in this manner. He wanted to know what limits a system would impose upon him that might curtail his ability to relate to students, and to help them learn the propositional, procedural and dispositional knowledge of science, in addition to life skills.

Thus, Dr. K's course, which focused on how a teacher thinks and acts as an effective secondary science teacher, did not adequately address course problems for either John's career choice or Gary's perceived system constraints on how a teacher functions. It did address Ray's problem of wanting prescriptions for teaching in an effective manner. In fact, it directly confronted Ray's inadequate conceptual patterns about teaching and demonstrated to him how a teacher's actions required more complex thinking than the desired prescription for the teaching solutions that Ray sought.

The knowledge the subjects had about teaching needed careful examination. Two pictures were developed about each subject's foundational knowledge of teaching. First, the dispositional knowledge was assessed to define what each subject believed an effective teacher looked like prior to having the chance to see what the ideal was like from Dr. K.. This was the subjects' idealized view of teaching.

A second picture of the fundamental knowledge of teaching a subject had was examined by their planning and implementing instruction task responses. In other words, the propositional and procedural knowledge base for teaching a subject held was assessed to define the subject's potential for learning from course experiences and functioning as an effective classroom teacher based on what they knew upon entry to the methods course.

The propositional knowledge base was examined by using a set of essential elements for a lesson, while the procedural knowledge was examined by the essential frames for planning described and used by subjects. These were dependent upon each other for functioning in decision making, and were combined to formulate the realistic view of teaching based on responses from three different situations. These three situtions were: a subject verbalizing about doing a teaching task; actually doing a noninstructional task, and then discussing it orally; and the inferences drawn from observations of the subject's actions while teaching a lesson. The composite of the three data source roles for teacher and students provided the parameters for defining the realistic view of teaching.

The Idealized View of Teaching

A pattern of conceptions defining an idealized view of teaching was derived for each subject from belief statements about questions such as the most important role for the teacher, judgment criteria for evaluation of another teacher's instruction and problems the subject anticipated students might have in learning science, and what they would do to make it easier to learn. The responses assessed the dispositional knowledge base about teaching, and defined specific roles for a teacher and for students. The combined role descriptions of the teacher and students defined an ideal, or goal teaching conceptual pattern each subject had as they began the methods course. This ideal teaching view was considered the subject's definition of an effective teacher and the circumstances they would strive to create in a classroom if they began teaching without further educational experiences.

Dr. K defined an effective teacher as a conceptual change creator, one who designed and implemented instruction with consideration of students' specific mental conditions in relation to specific science instructional content. Instructional decisions were related to the specific details of content and to sequencing the content based on the need to directly confront students' mental condition about scientific knowledge in instruction to result in student learning outcomes. Students, in Dr. K.'s model, were defined as having a proactive determiners role in instruction. Their mental level responses to activities provided the teacher information for decisions concerning the details of the scientific content which needed to be presented, along with how and when this should occur.

Gary, like Dr. K., wanted students to learn much more than the factual science information. Propositional, procedural, and dispositional scientific knowledge, and life skills were his desired learning outcomes for students. He defined the role of the teacher as a learning developer, one who used a variety of activities and teaching modes for instructing. His decision base for what details of content to include, however, were not influenced by students' mental conditions like Dr. K's were. Instead, students were active determiners, because the students' mental conditions, as assessed by the teacher, provided only general information he would use in making decisions related to how, and when, specific science knowledge content would be presented in a meaningful manner. He selectively used a wide variety of activities to mentally and physically engage students in learning, and by making content relevant to students' lives through application situations. Since Gary failed to account for students' specific mental conditons in relation to decisions about what content was presented, his instruction had the potential of being unintentionally miseducative. It could allow students to misinterpret the activities in which they were engaged, and reinforce inappropriate knowledge that an individual had despite Gary's continuous, preinstructional and postinstructional assessments of individual students' learning. Gary's problem in teaching would be in relation to diagnosing why some students failed to learn even though they were provided with lots of means for learning by the strategies he chose to use.

Both Ray and John believed an effective teacher was a learning facilitator. Ray, unlike John, however, believed that a teacher had the additional role of being a learning assessor. Brief lectures would be supplemented by a variety of instructional activities designed to involve students. Ray believed that students' understanding of content needed to be continuously assessed. His frequent assessment of individuals throughout a lesson required students' mental engagement in instruction. John, on the other hand, only required that students be physically engaged in the instruction. Both believed that learning would occur if students were interested in the content. Ray defined a role for the students as mentally and physically active responders in instruction, while John's ideal role for students was to be physically active responders. John believed students were all alike in relation to learning, while Ray included a teaching strategy addressed to meet individual learners' needs. Both Ray and John had limited learning outcome goals for students concerning scientific propositional knowledge. They just hoped that students would want to learn science beyond the memorization level.

In conclusion, the subjects' idealized roles for science teachers ranged from the desired science learning outcomes with the conceptual change and learning developer roles of Dr. K. and Gary to the learning facilitator role of John and Ray, which were limited by learners acquiring an understanding of scientific propositional knowledge only. The students' defined idealized roles were reflective of these goals. Proactive determiners and active determiners roles for students directly influenced the teacher's decisions about appropriate instructional actions to differing degrees. Mentally or physically active responder's role engaged students in teacher-selected activities which confirmed content presented to students, and involved students in the lesson thereby motivating them to learn science propositional knowledge content.

The teaching goals as defined by a subject not only determined how effective a teacher they could be in relation to the expert, but also addressed the theory they held about the learning process in individuals. This influenced both how the subject would design and implement instruction, and how the subject believed s/he would learn from personal experience as a teacher.

Dr. K. believed that a conceptual change model explained the learning process best. Gary held that a developmental model was best, while John and Ray presented beliefs in a behavioral model for explaining the learning process. The teacher and role descriptors used in this study reflected the subjects' orientation toward instructional goals and learning theory which served as the basis for determining the course of actions of students and the teacher in a classroom. The idealized role descriptors are the subjects' goal teaching conceptual view, which represents the framework in which their dispositional knowledge is held. Dispositional knowledge for teaching was important because it was used by the teacher to make judgements about alternative actions they defined in decision making and therefore, was the basis for deciding the most appropriate action to achieve the desired outcomes. In order for the dispositional knowledge base to influence actions in the classroom, the teacher's decision making process, which involves the subjects' propositional and procedural knowledge for problem solving, must result in more than one solution for possible action.

The Realistic View of Teaching

Subjects' patterns of conceptions based on responses to specific teaching tasks of instructing and planning situations were used to define respective teacher and student roles representing the subjects' propositional and procedural knowledge base of teaching. The roles of the teacher and students defined by a subject across all three data sources and two knowledge types were combined into one composite realistic view of teaching. This realistic view of teaching descriptors represents how a subject would probably function as a classroom teacher at the beginning of the methods course.

Both Dr. K and Gary defined identical roles and descriptors of the teacher's role in their idealized and realistic views of teaching across all data sets. Gary, like Dr. K., had a great deal of consistency in his mental framework for teaching. However, Gary's learning developer role was less effective a teaching style, because he failed to account for his students' specific mental condition in making decisions about the details of content necessary in instruction to ensure that students learned appropriate science knowledge.

Ray and John, however, had inconsistencies between their dispositional view of teaching and their realistic views of teaching. John had greater inconsistencies than Ray. However, both Ray and John have some specific knowledge of what they were to be about as teachers. John defined the realistic role of the teacher as that of a content authority presentor, in his clinical interview data and plan and recall data set. However, the role found in his microteaching data set was that of a content authority and activity director. The content authority teacher role was one who presents scientific propositional knowledge to students by lecturing to them, and expecting students' to be passive recipients of this information. Realistically, John and Ray viewed students as all alike in relation to learning. The activity director role, as exemplified by John on the other hand, presents a situation where students are engaged in activities for the purpose of occupying students to prevent classroom management problems. Learning that occurs is coincidental, and not the result of the teacher's design for instruction. In microteaching, John assumed the role of a content authority-activity director, with the students being physically passive determiners. Once they were given an activity their responses dictated to the teacher the new content he needed to present in the lesson. Hence, John whose narrowly defined concept of teaching was no longer functioning in relation to the situation in which he found himself.

Meaningful coexistance was questionable in relation to the purpose, just as the effectiveness of his teaching was questionable as to having a desired learning outcome or intent.

Ray's defined roles, like John's, were different for the microteaching situation than the teaching and planning situations of the plan and recall data, or clinical interview data. Ray's role for the teacher in microteaching was that of a content authority presentor and learning assessor. He presented content to students, and checked for student learning at the end of the lesson. Students were physically active responders in his lesson, but mentally passive recipients. Ray's teaching strategy did not require students to mentally participate in his lesson, and he did not have specifically defined learning outcomes. Instead, students were to "play around" with the equipment for awhile and learn from doing that. The alternative role for the teacher, as defined by Ray, was that of a learning instiller and assessor. Students are physically active responders in a lesson activity, but the activities they were asked to engage in were learning activities which reinforce science propositional knowledge the students already understood. Ray failed to have appropriate alternative instructional activities prepared in order to teach students new content. In other words, Ray's lesson trapped him in his own web, and although his web was constructed with a functional purpose of producing specific kinds of learning outcomes for students, he could not identify <u>how</u> or <u>what</u> it was that prevented him from achieving the purpose.

In conclusion, from a realistic view of teaching, the learning outcomes for students in either John or Ray's classrooms were questionable because of their limited propositional and procedural knowledge base for deciding alternatives for instructing. Student roles under a teacher's role of a learning instiller and assessor, content authority presentor, or content and authority and activity director do not require mental engagement by students in the instructional lesson design implemented. At best, under the learning instiller, students are held accountable for memorizing science propositional knowledge content, while the worst situation, that of a content authority and activity director, requires no accountability in relation to learning results. Lectures, or teacher demonstrations, were the consistent essential elements for presenting content in Ray's and John's lessons. Questionable activites selected for reasons other than learning, were the frequent characteristics of the essential frames for their planning. Ray's and John's defined roles addressed a low number of planning frames. Dr. K and Gary both addressed all planning frames, interrelating them to answer specific questions related to each of the five essential elements of a lesson which they defined in their teaching situation tasks.

There were gaps in Gary's knowledge base about teaching that made his potential teaching style less efficient in relation to meaningful learning outcomes for students than that of the expert's. The gaps, however, in the knowledge base of John and Ray were much greater than Gary's. In fact, they were to such a degree that effectiveness as a teacher was questionable to the extent that testing efficiency as a teacher was meaningless.

In conclusion, Dr. K. and Gary both had a high degree of cognitive consistency across all three types of knowledge which were a part of their mental framework for teaching. Gary needed to learn little more to become an effective secondary science teacher according to the criteria of this study. However for Ray, and to a greater extreme, John, the propositional and procedural knowledge bases about teaching as defined in this study were insufficient to operationalize their idealized views of teaching. In addition to their mental framework for teaching they also had conceptions of teaching which were discrepant with those of an effective teacher. John's mental framework was more discrepant than Ray's, because his ideal view of teaching, as a learning facilitator, did not include a need for continuous assessment of students learning in instruction. Pragmatically, John would learn that his teaching was inappropriate only by long range tests of student learning, while Ray would make sure he knew if reteaching was necessary within a daily lesson.

Thus, John's knowledge about teaching was very limited and very simple compared to Dr. K.'s or Gary's. In fact, John was not even sure if he knew why he needed to construct a mental framework for teaching a lesson to result in learning outcomes. There was a basic difference in definition for a lesson's conceived purpose than that for which teaching is defined to have by others. Ray understood this purpose of student learning outcomes to some degree, but was limited by other gaps and traps he constructed in his limited knowledge state in relation to teaching and this defeated the purpose when he was actually functioning as a teacher.

The Determinants of the Curriculum

Subjects' articulated long range planning processes, in response to the new teacher in a district scenario, resulted in conceptual patterns for the knowledge needed to make decisions about curriculum content, or course design. The specific factors about which Dr. K. would seek knowledge prior to making curricular decisions were: 1) students general mental abilities, and 2) resources such as laboratory equipment he had to use in his teaching.

Like Dr. K., Gary wanted specific information about students and resources, but also, he believed he needed to understand the system's expectations for the course and for his teaching. John and Ray only sought information about the textbook from which they would teach as a base for course curriculum decisions for a particular class. John believed the textbook dictated the parameters of what he should teach in a course. Ray viewed the textbook as the essential resource for teaching what he believed was important in science. Ray made decisions using the textbook where it helped him and ignored it at other times.

In addition to the specific-situation information each subject and Dr. K. presented, they each would use their own personal knowledge of science and teaching activities as determiners of the curriculum. The success or failure of the instruction as implied by the determinants, was the basis for inferring how the subject would improve his teaching with experience. Gary and Dr. K. each accounted for multiple factors about students, the environment and the resources and defined a curriculum which had flexibility for students as individual learners. They assumed responsibility for the learning success or failure, and accounted for this by structuring teaching in a way that derived feedback information from students and used this to adjust and modify the curriculum. What should be learned would be taught, and this was more important to both Gary and Dr. K. than covering a predetermined course curriculum. Ray and John developed a sequence of content as the course curriculum, and would adhere to it in their teaching. A major difference between John and the others, was that he did not believe he was personally responsible for the learning outcomes of instruction, rather, these were due to the inappropriateness of textbook content.

In conclusion, Ray's, Gary's and Dr. K's personal ownership of the curricula that they developed, provided them with an avenue for continually learning to be better teachers from their experience in the classroom. John's construction of the curriculum procedures provided him with a ready excuse on which to blame his failure as a teacher, and hence, did not require him to critically analyze his own teaching procedures in relation to student learning. John's situation was a relatively hopeless one in relation to his own self-improvement of teaching based on classroom experience. Ray would learn, but often would be puzzled about why his instruction was failing, due to his very limited propositional and procedural knowledge base about teaching and the minimal goals he defined for the outcomes of his teaching. Gary, on the other hand, had coalesced most of his knowledge about teaching into cohesive working mental structures which allowed him to function in a flexible and responsive manner with students, as well as continue his self-learning process as a teacher. These subjects mental conditions in relation to Dr. K's coalesced consistent mental framework for teaching are present in Figure 4.8.

Conclusions About Data Sources across Case Study Subjects

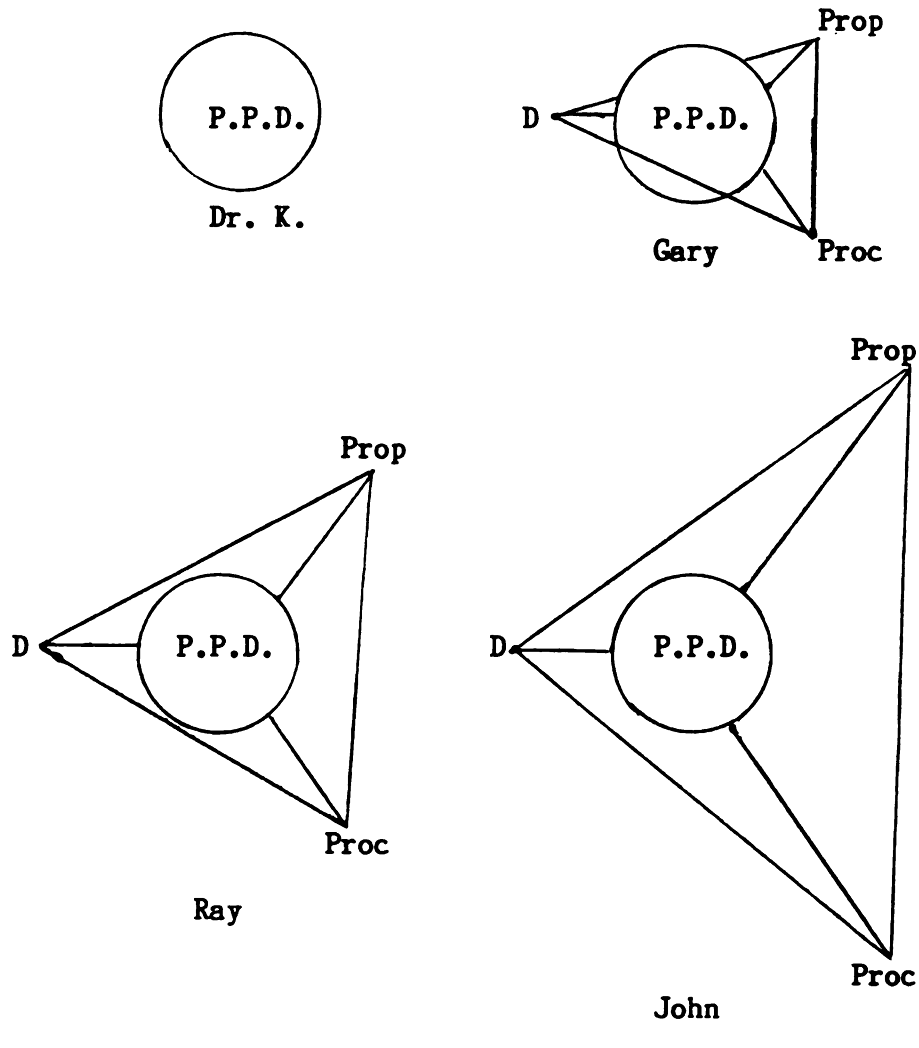
The three data sources (clinical interview, plan and recall interview, and microteaching lesson) as a basis for inferring teacher and students' roles from identified essential elements of a lesson, and essential frames for planning, were problematic for determining the separate propositional and procedural knowledge bases of a subject. Two working hypothesis emerged from the discrepancies evidenced by the three case studies. These hypotheses were used to analyze the additional nine study subjects.

The first working hypothesis in dealing with inconsistencies across all subjects was that a more complex view of teaching represents less discrepancies across all data sources for inferring a subject's conceptual patterns used to define roles for the teacher and students. In other words, Gary's data sources for essential elements of a lesson and essential frames in planning a lesson, consistently resulted in the

Figure 4.8

Case Study Subject's Knowledge Bases about teaching in relation to the expert's coalesced consistent knowledge base for effective teaching.

(Prop = Propositional Knowledge Base, Proc = Procedural Knowledge Base, D = Dispositional Knowledge Base, P.P.D. = All knowledge about teaching types)



same defined roles across all six data elements with few discrepancies in identified essential elements of planning frames, and their meanings. However, there were discrepancies in roles defined by Ray and John who had simple views of teaching, and less developed dispositional, propositional or procedural knowledge bases about teaching.

The second working hypothesis focused on the discrepancies which were found within data elements analyzed for Ray and John. There was not a consistent pattern of discrepancies across Ray and John, but explanations offered by Ray in his articulated planning procedures pointed out a key source of potential contamination in the lesson plan and planning recall data. Both Ray and Gary said that they went to the methods course textbook, or other education course class notes to define a guideline for formulating their written lesson plan. John did not. Based on this information, the hypothesis established was that the microlesson data source defined a picture of the subjects' propositional and procedural knowledge base of teaching at it's most limited range, while the plan and planning recall data defined an unrealistically "good" picture for a subject. The methods used in data collection and analysis were too limited to define a subject's distinct differences in propositional and procedural knowledge about teaching from the case study subjects' data sources alone.

Part II

Findings and Discussion

Introduction

The purpose of this study was to document preservice secondary science teachers' concepts about teaching as they began a methods course, and to assess two different course experiences as alternatives to clinical interviews for determining the concepts held. There were fourteen students enrolled in the science methods class, which was the setting of the study. All volunteered to participate in the study, but only twelve, four women and eight of the ten men, completed interview requirements to become the subjects of this study. The twelve subjects were epitomized by Gary, Ray and John as presented in detail in Part I.

This section will begin with a brief description of the subjects' background. To facilitate the contrasting and comparing of the findings, schematics and numbers were used to summarize findings. The nature of the work, problem for the course interpretation, and determinants of the curriculum issues are presented first. Then then idealized and realistic view of teaching are jointly presented. This chapter concludes with a summary of the subjects' conceptual patterns in relation to each purpose of the study.

The Subjects' Professional Status: Now and Future (see Figure 4.9)

Like Ray and Gary, the majority of the subjects were biology majors

Figure 4.9 Subject's Background Description and Conceptual Pattern About the Nature of a Teacher's Work.

Subject	Major	Subject Area For Future Teaching	Long Term Teaching Committment	Current Status/ Age	Nature of a Teacher's Work Conceptual Pattern (# of commonplaces)
Gary	Biology	Biology	No	Post B.S. (*)	Complex (#4)
Vickie	Biology	Biology	No	Senior	Complex (#4)
Ray	Biology	Biology	Yes	Post B.S.	Simple (#2)
Elsie	Biology	Biology	No	Senior	Complex (#4)
Richard	Biology	Uncertain	Yes	Post B.S. (*) older	Simple (#1)
Ryan	Biology	Biology	No (ed adm)	5th yr Senior	Simple (#2)
Jan	Environmental Education	Uncertain	No	5th yr Senior	Simple (#1)
Rick	General Science	Uncertain	Yes	5th yr Senior	Simple (#2)
Karen	Chemistry	Chemistry	Yes	Post B.S.	Simple (#1)
Brett	Math-Physical Science	Math	No (ed adm)	Post B.S.	Complex (#4)
Bill	Earth Science	Uncertain	No	Post B.S. (*) older	Simple (#1)
John	Earth Science	Uncertain	Yes	Junior	Simple (#1)

* (> 5 yrs work experience

(n=6). Two, including John, were earth science majors, the remainder were in the major areas of chemistry, general science, environmental education, and math. Like Gary, six others, three women and three men, had alternative careers to science teaching which they intended to pursue in the future. Two of the men in this group eventually wanted to be school administrators. Only five, including Ray and John, believed they would be career secondary science teachers when they began the course.

Conception Patterns about Teaching

The Nature of a Teacher's Work

Schwab (1969) defined the nature of a teacher's work as complex. His theoretical framework defined the four commonplaces as being teacher, students, curriculum, and milieu. Dr. K. also addressed these four areas as involving multiple factors which an effective teacher needed to understand. Dr. K. and Gary presented a complex view of the nature of the teacher's work with many contingencies and interrelationships among the four commonplaces. However, Gary only considered the task of instructing, and not the teacher's task of planning as complex. No other subjects in this study viewed the nature of the work as complex in the same way that Gary did, but four had similar understandings of the complexity of it as articulated by their thoughts concerning the rationale for choosing teaching as a career, and in the ways they believed they were prepared or unprepared to teach (See Figure 4.9).

Ray believed that the work of the teacher was to translate and present content to students. He addressed the commonplaces of students and curriculum in his articulated thoughts. Three other subjects had a similar simplistic understanding about the teacher's work.

Three subjects in addition to John defined the teacher's work only around the commonplace of curriculum. They believed that the work was simply presenting science content to students. They believed in as much as that since they had completed most of their science course requirements that they were prepared to teach. The exception in this group was Jan, who stated,

> "I feel I am prepared as such because I'm not afraid to get in front of kids and I'm not afraid of kids. You know, kids don't intimidate me." (I. I.)

She only considered the commonplace of the teacher in her responses instead of curriculum, which resulted in a simplistic view of the nature of a teacher's work.

In summary, there were four of the subjects who had complex views of the nature of a teacher's work similar to Dr. K.'s and Gary's (see Figure 4.9). Eight of the twelve had simple views that included only one or two of the commonplaces. Half of these subjects only considered the one or the other commonplace of curriculum, or students. The other half considered both curriculum and students. These differences define a general mental condition of subjects in relation to being, or becoming effective and efficient teachers. The four with a complex view had complex mental structures out of which to operate as they begin teaching. The subjects with a simple view have limited mental structures which required substantial additions for them to reflect the goal mental structures of an effective teacher.

The Problem for Course Interpretation

How does an effective teacher think and act? That was the problem that Dr. K. used when designing the science methods course instructional experiences. The course goals and objectives defined teaching as a set of complex mental operations of teacher decision making and judgment in the tasks of planning and implementing instruction. Multiple factors associated with each commonplace were presented as the elements effective teachers considered in order to define actions which would result in student learning. Good teaching was evidenced by high quality, purposeful interactions between teacher and students over science content. Dr. K. wanted his students to acquire specific propositional, procedural and dispositional knowledge about teaching in order to become effective teachers.

The basis for the subjects' thinking or decision making about actions as a teachers requires a particular reference concept for meaning. Only half of the subjects in this study, including Ray and Gary, had a clear picture of themselves as teaching a particular science content area as a basis for their thinking about teaching (see Figure 4.9). The other six, including John, had several areas of science they envisioned themselves teaching. The basic reference the subjects held for themselves in interpreting the course was this projected image. It was also reflected in the personal problems about teaching that the subjects defined for solving in the course (see Figure 4.10).

Gary, Ray, and John each had different problems they defined for course interpretation. With the exception of two subjects, all other subjects' problems were defined either by the case study subjects, or Dr. K.'s purpose for the course. The problem Vickie and Brett defined was that they wanted to learn to think and act as an effective teacher. Gary believed he knew this, but wanted to learn how the school system would affect effective teaching. He was not in harmony with the course content in that the course content did not directly address the problem he saw as his reason for taking the course.

Ray's problem for the course was the most prevalent among the subjects. He and four other subjects enrolled in the course hoping to acquire a set of prescriptions that told them how to act effectively as a specific subject matter course teacher. The methods course needed to provide a direct challenge to these subjects' conceptual patterns about what was required in order for them to be effective teachers. Their personally defined problems for interpreting the course reflected their limited understanding of the nature of the work. Because the problem addressed how a teacher acts, it, in part, matched the defined problem of the course.

John and one other subject defined a career choice problem. They sought general information about what secondary science teaching was like in order to decide if they wanted to enter the profession. Their central focus was on themselves, and not on learning how to teach.

Figure 4.10

Subjects' Conceptual Patterns of the Problem Defined for Course Interpretation.

Conceptual Pattern	Collection of Activities for Teaching	What is Teaching Like?	How to Act Like a Teacher?	How to Think and act Like an Effective Teacher?	
		Career Choice	Prescription for Teaching	System	General
Case Subject		John	Ray	Gary	Dr. K.
	Bill	Richard Rick	Karen Jan Elsie Ryan		Vickie Brett
# Subjects	1	2/3	5/6	3	

Potentially, they would misinterpret the goals and objectives of the course as defined by Dr. K..

Two subjects, Rick and Bill, were exceptions. Rick, a former pre-medicine major, was fairly sure he would teach. His problems combined those of Ray and John. Bill's problem for course interpretation was, "How do I locate a collection of activities or experiments that will keep students interested?". He said,

> "I think of experiments that can keep the kids interested, the funny ones, the ones that are not just boring the heck out of them. So that is why I feel that I have to do, which I want to do this year. I want to try and find books that I can get the experiments that keep the kids' interest. You know, the kind where you swing a tire out in the tree instead of the little pendulum inside, just to keep the kids into their energy. And I think that right now I am not too prepared for that. I feel adequately prepared or intellectually (prepared) from school." (I. I.)

Bill wanted specific and selective knowledge about activities that would engage students. There was little content in the course objectives or goals which directly related to his problem.

In summary, two subjects had a high potential for solving their problem in interpreting the course, because they were identical to that defined for the course, i.e. how to think and act like an effective teacher. Five other subjects had a problem which encompassed only the desire to acquire effective prescriptions for teaching. They had a good potential for learning about effective teaching because they wanted students to learn despite inadequate conceptions they brought to the class. The problems of five other subjects were tangental to the content of the course. The problems of career choice information, content of the course. The problems of career choice information, understanding system constraints on a teacher, and collecting interesting activities to use with kids were not directly related to enhancing teaching which would result in student learning. Instead, the career choice focused on a concern about self as being a teacher, while the other two focus on the system as influencing self as teacher. In conclusion, seven of the twelve subjects had high potential for learning to be more effective teachers based on their problem for interpreting the course. Five of subjects' conception patterns were questionable in relation to subjects' interpretation of the content delivered.

The Determinants of The Curriculum

A situation all the subjects would one day face was that of becoming a new teacher in a school district. Furthermore, experienced teachers must redefine a curriculum for each course they teach. Effective teachers do long-range and short-range planning. The decisions made in formulating the course curriculum defined mental parameters for minimizing the amount of information which a teacher must include in daily or short-term planning and implementing decisions, and defined a general system of feedback to the teacher for assessment of their own teaching as reflected by students' successfully learning.

As defined by Dr. K., the specific knowledge needed by an effective teacher before s/he can design the curriculum for a course were the resources available for teaching, and the students' general mental conditions. This knowledge, along with the teacher's own scientific knowledge base, and collections of teaching activities determined the basis for making decisions and judgements about the appropriate curriculum for the course.

All subjects included their own personal knowledge base of science, and a collection of activities for teaching science as curriculum determinants. Two subjects believed this was enough knowledge to appropriately design a course. Most subjects, however, wanted specific situational information (see Figure 4.11). Five, like John, wanted knowledge about the textbook to decide what order the content of the textbook should be presented. The textbook was the determiner of the curriculum for them. Two, including Ray, wanted information about the textbook to evaluate where it could appropriately be used in relation to teaching a course. They viewed the text as a resource for teaching, rather than a determiner of the curriculum.

Gary and two other subjects were concerned about collecting information about multiple situation-specific factors for appropriate decision-making about the curriculum. Gary and Elsie each defined knowledge about the system as an essential component, in addition to the students and teaching resources available for use. Vickie showed no conflict in Dr. K.'s determinants in her knowledge base of this area. In relation to other literature on effective teaching, Gary and Elsie presented the most accurate determiners by including both external and internal factors of the classroom as determinants of the curriculum (Hatfield, unpublished; Farmer & Farrell, 1983).

internal and external factors to the classroom situation as determinants of the curriculum beyond the teacher's own knowledge of science and teaching activities. Seven subjects had conceptual patterns which showed the textbook as the situational factor about which they needed to acquire information in order to make curriculum decisions. Two of these subjects' conceptual patterns did not require information about a particular situation. They believed the teacher could do long-range planning for a course independent of the situation.

Long-range planning facilitates a teacher's decision-making process by establishing a mental set in relation to the number of factors, associated with the commonplaces of teaching, which an effective teacher must consider in relation to both the daily planning for instruction, and immediate instructional decisions. The more effective the mental guides and goals are, i.e. the more aspects of each commonplace determined as important or not within the structuring of the curriculum, the fewer the factors for each variable there are that require the teacher's consideration to define appropriate actions in response to the situation. The mental set cues the effective teacher as to what information to take in from the teaching context continuously, and determines the specific criteria for judging a decision. The effective teacher is an efficient decision maker with a mental set which guides and directs the interpretation of the situation in relation to the specific information needed relating this to each of the commonplaces during instruction; and in judging appropriate action responses to students. Long range planning is facilitated by limiting and clarifying appropriate factors of the context of teaching.

Most subjects of this study only defined a mental set in relation to the curriculum commonplace, where as Dr. K., Gary, Vickie, and Elsie eliminated enough factors about all commonplace variables to guide them in efficient decision-making relative to the circumstances they would encounter as teachers, and to guide their judgments for effective actions in relation to the goals of student learning. The underlying problems of the other subjects' conceptual patterns for long-range planning tasks were pragmatically stated by Karen as,

> "I would probably take more time to think. Like, I would take a longer time to make decisions because I don't have the experience." (I. I.)

Based on human information processing theory (Resnick, 1981, 1985; Shulman and Elstein, 1975), she was most accurate in her description of the results, but inaccurate in her explanation of the influence experience would have on her mental abilities related to being an effective teacher. She brings to bear the need for more than trial and error type classroom experience as a basis for developing efficient and effective decision making strategies in order to achieve appropriate goals.

A second significance of the determinants of the curriculum conception patterns was the ability of the subject to learn from experience. The five subjects who determined the curriculum based on the textbook provided themselves an easy justification for failure of student learning. They could readily blame the textbook as being inappropriate for their students and not need to re-examine their teaching for modifications and improvement. They had a low potential for self-learning. The other subjects all assumed personal responsiblity for what was taught and would probably question their teaching if student learning problems occurred. The extent to which they were able to question themselves and make self-improvements was reflective of their knowledge base for teaching. The ability to personally define the problems experienced in teaching would be directly related the knowledge the individual brings to the circumstance (Resnick, 1981, 1985; Shulman and Elstein, 1975).

The Idealized and Realistic Views of Teaching

Introduction: The idealized view of teaching represented the dispositional knowledge about teaching a subject had as the science methods course experience began. This is the knowledge base used in judging the alternatives for actions in relation to a teaching situation according to Shulman and Elstein (1975). The realistic view of teaching was the decision-making knowledge base representing a combination of the subjects' propositional and procedural knowledge about teaching.

The idealized view was derived from roles for the teacher and for students as determined by the clinical interview responses of expressed beliefs, attitudes and values about teaching. The realistic view was derived from specific teaching knowledge application tasks completed by the subjects in the clinical interview, and two course experiences of 1) planning a lesson with a recall interview, and 2) microteaching of the planned lesson to sixth grade students.

The subjects' conceptual patterns representing propositional knowledge was derived from the set of standard lesson elements defined as essential for effective teaching (Good & Brophy, 1984; Rosenshine, 1984). The essential lesson elements and the meanings ascribed to them by a subject defined a role for the teacher, and a role for students in instruction, which was compared across all data sets. The procedural knowledge base used to define the roles of teacher and of the students was derived from conceptual patterns about daily lesson planning articulated in interviews and inferred from the microteaching lesson. The situationally applied teaching tasks involving daily lesson planning were used to determine the subject's procedural knowledge about teaching. The base used to derive the conceptual patterns and meanings given them, were the frames of planning addressed (Smith & Sendelback, 1982; Slinger & Anderson, 1982). The essential frames for planning were inferred from the microteaching lesson actions, clinical interview responses, and written lesson plan and recall interviews in which the subjects were asked to articulate what they thought about as they planned. The essential frames for planning a lesson and their ascribed meanings defined specific roles for the teacher, and for students in instruction which were compared across all data sets as well as with the dispositional knowledge base of a subject.

The teacher role and the student role, as defined by subjects, resulted in very different portrayals of teaching across subjects. The contextual clues used to define the teacher's role descriptors were: the knowledge outcome goals of instruction, and the theory of learning held by the subject. For example, a learning developer was a teacher who believed, or used a developmental model to explain the learning process and encouraged students to learn more than just propositional scientific knowledge. The student's role descriptions as viewed by the subjects, were summarized by descriptors that told of the mental and physical actions expected from students in relation to the learning process. For example, if students were physically passive determiners, they were expected to be physically engaged in the science activities of the lesson. The teacher did nothing to ensure mental engagement in the structuring of the activity, and as a result, the students' action responses could result in situations causing the teacher problems which the teacher could not just ignore in the decisions made within a lesson. Students were determiners of the instructional action once it was initiated by the teacher.

To determine the type of knowledge the subjects had about effective teaching, the roles ascribed to teachers and students by the subjects was compared to those of Dr. K.. Examining these roles provided indicators for 1) how effective a teacher the subject would be with the current state of their knowledge, and 2) the individual's potential for learning to be an effective teacher from classroom experience, or course experiences. For example, Karen thought she would become a better decision-maker with experience, but she lacked the knowledge needed to make this conception of herself a reality. This was explained by contrasting and comparing the issues of an idealized and realistic view of teaching. These issues provided a base for comparison of subjects to the expert in order to define the gaps in knowledge that the subject had about teaching within his/her own mental framework for teaching and the knowledge base defined by the expert as necessary to be an effective teacher.

The subjects' roles for teachers and students defined descriptors were used to create relational scales in order to compare the knowledge bases of subjects with that of an effective teacher. Dr. K. represented the goal conception patterns at the zero positions. The goals for learning outcomes and learning theory in relation to Dr. K., determined the ordering of all teacher role determinants on the teacher's role scale. Each type of teacher was defined as one unit. Thus, a scale of zero to six was developed for determinants of teacher roles as follows: the goal descriptor conceptual change creator, was defined as zero; one was the learning developer, two was the learning facilitator, three was the learning instiller and assessor, four was the content authority presentor and assessor, five was the content authority presentor, and six was the content authority-activity director role.

A similar scale was developed for students with proactive determiners being defined as the descriptor with a value of zero, and the range of other descriptors defining a scale of one to eleven (see Figure 4.12). The students' role descriptors were based on the effects of students on how a teacher determined <u>what</u> would be taught, <u>how</u> it was taught, and when it was taught. Student characteristics of mental or physical engagement served to define decisions about how something would be taught. This was related to the activity selection base defined by subjects as being learning centered. What was to be taught was defined by the passive, active and proactive adjectives, in relation to students' influence on a teacher's decision about content details. This was based on the objectives and learning outcomes defined by subjects for instruction. The recipient, responder, and determiners characteristics influenced when something was taught. This was based on the assessment strategy of the subject. The goal conception was for students to be mentally and physically proactive determiners in instruction while the physically passive determiners were the least influenced by a teacher in relation to learning what was intended or defining intentions for learning in a lesson.

In making comparisons across subjects, the ranked relative scales were given arbitrary values of one for each position away from the goal conception. The addition of the number of places away from the goal conceptions for both students' and teachers' roles were used as the numerical comparison base for representing the gaps or distance within a subject's own types of knowledge and between a subject's knowledge base for teaching and that of the effective teacher. The idealized role of the teacher defined by the subject in relation to the expert determined the distance between conceptual patterns of the subject and those of the

Figure 4.11

Subjects' Conceptual Patterns about Determinants of the Curriculum; Situation Factors for Course Planning.

Situation Factor(s)	Textbook		Multiple Determinants	
	Defines	Resource	Student Resources	Student and System Resources
Subjects' Names	John Karen Ryan Rick Richard	Ray Brett	(Dr. K.) Vickie	Gary Elsie
# of Subjects	5	2	1	2

effective teacher, while the comparison of the subject's ideal view of teaching and realistic view represent the gaps within the subject's own mental framework for teaching. This represented a numerical determined base for comparison among the subject's ability to operationalize his/her knowledge about teaching at the outset of the methods course. The gaps within and between the subjects' knowledge base in relation to an effective teacher, defined the potential of the subject for learning from the course and from classroom experience.

The Goal Idealized View of Teaching: Dr. K.'s defined role for an effective teacher was that of a conceptual change creator and his role for students was mentally proactive determiners. Students' mental condition in relation to specific scientific knowledge determined what details of science content needed to be presented, how these were to be appropriately presented, and when they needed to be presented in instruction. His judgments in instruction were guided by the goal for individual student learning, better described as the individual's need to acquire new mental structures in relation to their propositional, procedural, and dispositional knowledge base.

Differences Between A Subject's Idealized View and the Effective Teacher's Knowledge Base: Six of the subjects, including Gary, had little difference between their dispositional knowledge base for teaching defined descriptor and that of the effective teacher's (see Figure 4.12). They were only 2 or 3 total determinants from the goal conceptions of the expert (See Table 4.1a). The problem these subjects

Figure 4.12

Subjects' Distribution in relation to relative Scales of Descriptors for Teacher and Student Roles

Teacher's Role Scale	Content Authority Activity Director 6	Presentor 5		Presentor & Assessor 4	Instiller & Assessor 3		Learning Facilitator 2			Developer 1		Conceptual Change Creator 0
Teaching/ Learning Goals	Questionable Management Concerns				Scientific Propositional Knowledge					Science Dispositional, Propositional and Procedural, plus Life Skills		
Subject Idealized View of Teaching				Ryan	Rick		John	Ray Richard Karen		Jan Brett	Gary Vickie Bill Elsie	Dr. K.
Subject Realistic View of Teaching	Richard	John Ryan Rick Jan	Karen		Ray Brett Bill	Elsie			Vickie	Gary		Dr. K.
Students' Role Scale	11	10	9	8	7	6	5	4	3	2	1	0
Passive Recipients		M & P	M	M & P	M							
Passive Responders												
Passive Determiners	P		P		P	M & P	P	M & P	M	M & P		
Active Responders											M & P	
Active Determiners												M & P
Proactive Determiners												
Treatment of Students	Homogeneous Group									Heterogeneous Group		

Key: M = Mentally P = Physically

Table 4.1 a,b,c

Gaps in Subjects' Knowledge Base for Effective Teaching

	A. Differences Between Expert and Subject			B. Differences Within Subject's Own Knowledge			C. Total Knowledge Gap
Subject	Teacher Role	Student Role	Totals	Teacher Role	Student Role	Totals	Knowledge
Gary	1	1	2	0	0	0	2
Vickie	1	1	2	1	3	4	6
Bill	1	1	2	2	6	8	10
Elsie	1	1	2	2	5	7	9
Jan	1	2	3	3	8	11	14
Brett	1	2	3	2	5	7	10
Ray	2	4	6	1	3	4	10
Richard	2	4	6	4	7	11	17
Karen	2	4	6	3	5	8	14
John	2	5	7	3	5	8	15
Rick	3	7	10	1	3	4	14
Ryan	4	8	12	1	2	3	15

had was one related to their learning theory conceptual patterns. They held a developmental model instead of a conceptual change model of learning. Two of these six subjects had a second problematic conceptual pattern related to assessment of student's learning for pacing or sequencing instruction. They defined students as responders, thus had a conception of teaching which encompassed only post-instruction assessment of students' learning from their teaching.

The other six subjects had greater difficulty in their conceptual patterns which involved both the learning goals and theory teacher descriptor characteristics, and students' role characteristic differences. Four subjects with determinant difference scores of 6 or 7 did not have a specifically defined learning theory. Rather, they used both a behavioral and a developmental theory to varying degrees. The goals for learning they held were restricted to science propositional knowledge outcomes. The key difference between John and the other three in this group, was the assessment strategy used. John's conceptual patterns called for an assessment of students on a long-range time frame with a view of students as homogenous individuals. The other three learning facilitators viewed students as individual learners, and included concepts for continuous and post-assessment within the patterns that defined their idealized view of teaching.

The last two subjects, Rick and Ryan, had large gaps in their knowledge about teaching in relation to that of an effective teacher. Their problematic conceptual patterns encompassed all characteristics of students and of the teacher. They each had a behavioral learning theory pattern, and vague objectives and learning outcomes related to science propositional knowledge. Students were viewed as homogenous, mentally and physically passive recipients or, in Rick's case, as physically active responders. Thus, Rick and Ryan had conceptual patterns that encompassed a basic lack of goals for instruction and behavioral learning theory orientation for teaching. They did not believe students influenced teaching in relation to deciding what, how, or when something should be taught. However, both did express a belief in assessment of students for learning.

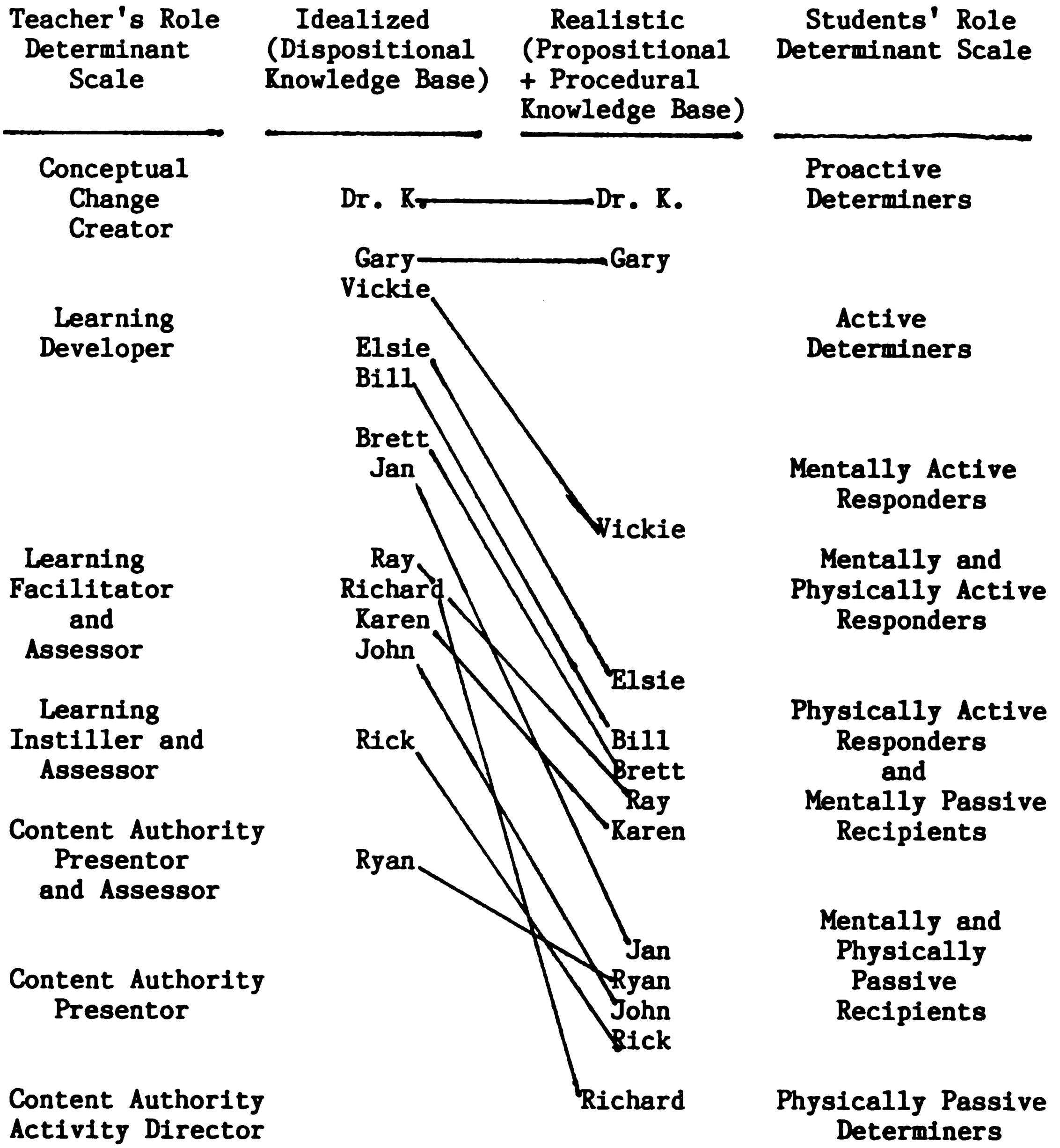
In summary, the potential for the subjects to learn from the course or from a teaching experience, based on the differences between their dispositional knowledge about teaching when entering the course and that of an effective teacher, was high for the group of six who only had learning theory related conceptual pattern problems, but less for those with both teaching goal and learning theory problems. The two with the greatest gap in knowledge, Rick and Ryan, probably had the least potential to learn, because they seemed to understand teaching for learning outcomes the least. In effect, they probably had such a limited understanding of what the teacher's and students' roles should be, that much of the information presented in the course would be misinterpreted, because of their limited entry level dispositional knowledge about teaching. In a practical sense, they would focus on information about the teacher delivering content and managing students' behavior without a concern for engaging students mentally, or addressing individual student differences in relation to learning needs. Although they would assess students in relation to learning, it is probable that their current understanding level would render them helpless in diagnosing or defining what the problems were if students did not learn, and their limited knowledge would make the solving of problems about student learning extremely difficult. They seemed to know only about lecture or one type of lab activity to use to engage students in learning. They were very limited in their knowledge and consequently, limited in their potential to learn from the course or from experience.

The Realistic View of Teaching

The Gaps Within a Subject's Own Knowledge About Teaching: The difference between the realistic and ideal views of teaching defined by the relative descriptor scales indicated that only one of the subjects, Gary, had a high degree of cognitive consistency within his mental framework for teaching (see Figure 4.12). The conceptual patterns he defined based on his dispositional knowledge about teaching were the same as those he defined based on his propositional and procedural knowledge bases. The other subjects all were functioning at less than the ideal level they held for themselves in relation to teaching (see Figures 4.12 and 4.13).

Vickie and Ryan were set who had little variance within their own knowledge types in relation to goals for learning and learning theory conceptual patterns they held. They differed in relation to concepts of students assessment. Vickie failed to preassess students in relation to

Figure 4.13 Subject's differneces in Teacher Views - Knowledge relationships within subjects' own mental framework and in relation to goal concepts.



learning outcomes while Ryan, who had vaguely defined learning outcomes associated with his idealized view of teaching, neglected to assess learning at all in his realistic view of teaching.

A third set was Ray and Rick. The difference within their own knowledge base involved learning theory as well as goals. Ray had a developmental emphasis in his idealized view with science propositional knowledge as the desired outcome. He operationalized this using a behavioral learning model as a learning instiller. However, he had limited outcomes for students in relation to the use of class time. Rick's problems were similar to Ray's, but like Ryan in the second set, his idealized view involved limited learning goals, and when operationalized, there was no clear indication that instruction had a learning purpose.

The fourth set, Bill, Elsie, Brett, Karen and John, had a much bigger gap between their dispositional knowledge about teaching and their propositonal-procedural knowledge (see Figure 4.13). Not only did the goals and theory of learning conceptual patterns change, but also the students' roles changed from determiners, or responders, to that of responders or recipients respectively. Practically, instead of the teacher assisting students with learning by selecting activities for students in which to be mentally engaged and to learn by doing, the students became confirmers of the learning presented to them through activities, or lecture by the teacher. The key difference was that students' mental involvement for learning was no longer an essential factor in the teacher's decisions about how to teach content to students for this group of subjects.

The final set, Jan and Richard, were subjects who had high ideals of teaching, but virtually no specific propositional and procedural knowledge to enable them to operationalize their ideals. They believed a teacher should develop multiple types of learning in students. Realistically, it was questionable if any student learning was the result of their presentations of content. In practice, their ability to be effective teachers was determined only on the management of students in a classroom. The limited propositional and procedural knowledge base, as evidenced by Jan and Richard, would make it unlikely that they could define the problems encountered as teachers, let alone solve these with any degree of effectiveness either as these related to student learning, or their own learning from experience as a teacher.

Discussion of Idealized and Realistic Views of Teaching

The individual subject's potential for learning arises out of the knowledge s/he already has. How readily the twelve subjects could learn from the course or from teaching experience was reflected in the totals for the knowledge gaps between the subjects' ideals and the effective teacher's ideal and the gaps within the subject's own knowledge base (See Table 4.1b,c). Gary and Vickie, with total determinant differences scores of two and six respectively, were subjects who had a good knowledge base of teaching and had the ability to learn from experience with the knowledge they already had as they began the methods course.

The key problem they had was a developmental model for learning they held, instead of a conceptual change model.

A second group including Ray, Elsie, Bill, and Brett, had totals of nine or ten determinant difference scores (see table 4.1b & c). They had gaps within their own knowledge and between their own knowledge and that of an effective teacher. They had sufficient knowledge to enable them to learn to be better teachers from experience, but needed more knowledge to be effective teachers. Their problems were with the learning theory they held, and also with conceptual patterns as they related to learning outcomes, and students' characteristics as these related to instruction. While they had a lot to learn, they began the methods course with a base of knowledge upon which to build.

The third group, with determinant score differences ranging from fourteen to seventeen, had large gaps in their own knowledge bases about teaching, as well as between their ideals and those of an effective teacher's conceptual patterns (see Table 4.11a,b,c). They had a limited knowledge base to use in defining or solving problems of teaching on their own, either to learn from course experiences, or from classroom experience.

In summary, two of the twelve subjects, including Gary, had little they needed to learn from a methods course to become effective teachers. Four of the subjects, including Ray, entered the course with gaps within their own knowledge, and between their own knowledge and that of an effective teacher. However, they had a base of knowledge on which to build. Six of the subjects, including John, had great gaps in their knowledge bases regarding being an effective teacher. These six had very limited knowledge about teaching required to define problems for themselves to solve in the course experiences. It is questionable if the propositional and procedural knowledge they had would allow them to make effective decisions by allowing for alternative actions in which they could use their dispositional knowledge. In the long term, this would prevent them from learning from classroom experience and interfere with learning from the methods course.

Comparison of Data Sources for Defining Propositional and Procedural Knowledge Bases for Subject

The second purpose of this study was to assess three different data sources for use in inferring students' concepts about teaching. The three data sets used were clinical interviews; the plan for a inquiry science lesson and recall interview; and the microteaching lesson transcript. These were each assessed for the propositional and procedural knowledge base about teaching for each subject. Propositional knowledge was defined as the conceptual patterns derived from the lesson elements presented and involved subjects' responses to applied teaching situations. Procedural knowledge was defined as conceptual patterns inferred from the frames addressed in the written plan or a daily lesson, in interview responses requiring application of knowledge to planning situations, and from the observations made of the microteaching lesson.

Data sources were assessed in several ways. First, the agreement of teacher's and students' roles defined by the essential elements of a lesson, or essential frames for planning and their meanings across data sets was assessed. There was only a 7.5% agreement across all three data sets for planning frames, and 12% for the essential elements of a lesson defining teacher and student roles. The total two-way agreements across data sets for students' and teaching roles for planning frames were 15%, and 20% for essential elements of a lesson. Across data sets there was no clear pattern of agreement or disagreement discernible. Thus, the methods were ineffective for defining specific independently determined propositional and procedural knowledge bases for a subject by the division of planning and teaching tasks.

A second way of assessing the data source agreement was to compare the roles for the teacher and for students' derived from the essential elements of a lesson, or essential frame of planning for the same data source for each subject. Coding of each data source was done independently, and the essential elements for a lesson data responses were first assessed for all subjects prior to assessing the essential frames for planning data. The responses and procedures for doing this for each data set are presented in Chapter Two. The role for the teacher and for students each subject defined in the clinical interview data were in agreement between the essential elements and frame determining responses, 75% for the teacher's role and 50% for the students' roles across all subjects. For the planning data set only subjects' own defined roles for the teacher were in agreement 75% of the time for the teacher, and 75% of the time for students'. The microteaching data set had the highest agreement for the teacher with 91% and 66% for the students. These findings, in relation to the data sources, indicate that the soures were problematic for defining different propositional and procedural knowledge bases for a subjects based on the planning frames or lesson essential elements. However, since all the lesson elements and planning frames were inferred from responses, or application situations the subjectiveness of the analysis procedures was very high.

The final assessment for reliability, in relation to the findings of this study, was to provide an outside coder with information describing the descriptors of teacher's and students' roles, and specified responses identified as associated with each of the three knowledge types across the data sets. This independent coding, by two different coders, resulted in an 87% agreement for the roles defined for all subjects across all data sets.

Thus in summary, the essential elements of a lesson and essential frames for a lesson plan and their meanings compared across data sets was a questionable analysis procedure. However, given the high intercoding rating the findings of this study are valid with a need to refine analysis procedures in future studies if a separate defined propositional and procedural knowledge base of subjects would be of importance.

Several clues to the causes of differences across data sets were found in final interviews with subjects. For example, some subjects used the course textbook to derive a guide for planning the lesson, the influence of working in teams with some plans completed almost as joint efforts, as well as the variation in the students assigned to different microteaching teams. These examples suggest that the best source for inferring the conceptual patterns for procedural and propositional knowledge combined is the clinical interview data set. The weakness associated with this, however, was that only one question assessed the essential elements of a lesson and only one question assessed the frames for planning. Therefore, the standard procedures for triangulation of data was not possible within the set of questions used for clinical interview as the only base for findings reported in this study in relation to the propositonal and procedural knowledge base of subjects. What was reported was the best match across the three data set sources to ensure triangulation of data for findings in this study.

Summary of Findings

In reviewing the conceptual patterns of all subjects across all issues, several sets of alike students were found (see Figure 4.14).

One set of three subjects, John, Richard, and Rick, had a very limited understanding of teaching when they began the course. They defined the work as simple with only a commonplace of curriculum. In this instance, the textbook determined the curriculum for their

Figure 4.14

Summary of Subjects' Conceptual Patterns and Potential for Learning from Methods Course or Teching Experience.

Subject	Nature of Work	Problem for Course	Curriculum Determinants	Idealized Teacher's Role	Realistic Teacher's Role	Potential for Learning Course/Experience	
Bill	Simple (1)	Collection of Activities	None	Learning Developer	Learning Instiller and Assessor	?	?
John	Simple (1)	Career Choice	Textbook (defines)	Learning Facilitator	Content Authority Presentor	Low	Very Low
Richard	Simple (1)	Career Choice	Textbook (defines)	Learning Facilitator Learning Assessor	Content Authority Presentor	Low	Very Low
Rick	Simple (2)	Career Choice	Textbook (defines)	Learning Facilitator Learning Assessor	Content Authority Presentor	Low	Very Low
Jan	Simple (1)	Prescriptions for Teaching	None	Learning Developer	Content Authority Presentor	?	?
Karen	Simple (2)	Prescriptions for Teaching	Textbook (defines)	Learning Facilitator Learning Assessor	Content Authority Presentor-Assessor	Medium	Medium
Ryan	Simple (2)	Prescriptions for Teaching	Textbook (defines)	Content Authority Presentor-Assessor	Content Authority Presentor	Medium	Low
Ray	Simple (2)	Prescriptions for Teaching	Textbook (resource)	Learning Facilitator Learning Assessor	Learning Instiller and Assessor	High	Medium
Elsie	Complex (4)	Prescriptions for Teaching	Multiple Factors	Learning Developer	Learning Instiller and Assessor	High	Medium
Brett	Complex (4)	Think and Act Effective Teacher	Textbook (resource)	Learning Developer	Learning Instiller and Assessor	Very High	Medium
Vickie	Complex (4)	Think and Act Effective Teacher	Multiple Factors	Learning Developer	Learning Facilitator and Assessor	Low	Very High
Gary	Complex (4)	Think and Act Effective Teacher	Multiple Factors	Learning Developer	Learning Developer	Low	Very High
Dr. K.	Complex (4)	Think and Act Effective Teacher	Multiple Factors	Conceptual Change Creator	Conceptual Change Creator		

teaching, and they functioned as content authority presentors with large gaps in their knowledge bases about teaching. They had a limited understanding of teaching and they were not sure they wanted to be teachers. Their limited understanding was an inadequate knowledge base in relation to the goals and objectives of the methods course. They had a high potential for misinterpreting the content of the course and little knowledge to use in defining, let alone solving problems in relation to student learning or their own learning to become a better teacher from experience.

A second set of three subjects, Ray, Brett, and Elsie, had a good potential for learning from experience and from the methods course. They were focused on learning outcomes for students in relation to teaching by their simple or complex views of the nature of a teacher's work involving, at the least, the commonplaces of students and curriculum. They were, at the minimum, actively seeking prescriptions for how to teach, and used the textbook as a resource in teaching. They all defined the realistic role of the teacher as a learning instiller, although their ideals for teaching were higher as facilitators or developers. They had gaps in their knowledge bases, but always assessed students for learning. Thus, the knowledge they had was a base for them to use in interpreting and learning from the methods course experiences or classroom teaching experience. They had a gap between their ideal and that of an effective teacher, but could understand teaching circumstances well enough to define the problems and begin to solve them by trial and error experience, and they would learn from the assessment of student learning results.

The third set of subjects was that of Vickie and Gary. They had a good understanding of teaching when they entered the course. They viewed the work as a complex task, were concerned about student learning outcomes, wanted to function as effective teachers, and considered multiple particular factors related to the teaching situation in defining the curriculum. They functioned with a high degree of cognitive consistency between their idealized and realistic views of teaching and had only one key problem in their knowledge base for teaching, the developmental model instead of a conceptual change model for explaining learning. They had an excellent knowledge base for defining and solving teaching problems that involved a concern for individual students as learners with a variety of needs to be met. They would definitely learn from experience in the classroom. However, learning from the methods course was limited because of the high understanding level they had of the goals and objectives for the methods course at the outset of the course.

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Chapter V

Conclusions and Implications

The two purposes of this study were to document the concepts about various aspects of teaching held by preservice secondary science teachers as they began a methods course and to assess three different data sources as a basis for identifying concepts held about teaching.

This chapter began with general conclusions for the study. Then conclusions for each of the aspects of teaching were individually presented with directions for future research studies summaries for each issue. The conclusion section ended with a discussion of the data sources in relation to identifying held concepts of subjects. The implications for the study followed. They were presented in reference to future research needed, design of science methods course instruction and in general in relation to preservice, or inservice education programs and teacher evaluation.

Conclusions and Future Research Directions

This study was an extension of an earlier study which began to define concepts about teaching as a base for determining changes in preservice teachers as a result of methods course experiences (Slinger & Anderson, 1983). A major conclusion drawn from this study was that Schwab's commonplace framework for teaching alone was inadequate for examining differences among the subjects in relation to becoming, or being effective teachers. However, the commonplaces used in conjunction with the cognitive science theories of problem solving, and information processing applied to learning, teacher decision-making, and judgment-making resulted in defining conceptual patterns which delineated clear differences among the subjects in relation to their differing levels of understanding teaching, as well as being able to function as teachers.

Five issues about teaching and learning emerged from the data as significant in relation to subjects' differing conceptual patterns which defined a potential for learning from the methods course, or the classroom experience. The five issues assessed were: the nature of the teacher's work, the problem for course interpretation, the idealized view of teaching, the realistic view of teaching, and the determinants of the curriculum. Underlying each of the issues were specfic concepts and patterns subjects' held that were identifiable as problematic in relation to being or becoming effective teachers. However, the methods used in this study were not adequately refined to identify all the specific problematic concepts that subjects held or lacked in relation to being or becoming effective teachers.

In regard to the conceptual patterns of the subjects about their view of the nature of the teacher's work, most subjects had simple views. Four of the subjects had such simple views that it was questionable if they had an adequate knowledge base to use in order to learn from the course. This general knowledge about teaching was explored further in the subsequent issues of the problems they defined for course interpretation and more fully in their idealized and realistic knowledge base for teaching defined by the specific types of knowledge a subject held as they began the course.

A conclusion drawn in relation to this simple view about the nature of the teacher's work issue is one related to the stages of concern identified by other researchers for teacher development (Fuller and Bown, 1969). A question for future research, which the subjects' conceptual patterns projected in reference to the teacher's work, was whether or not the process of committing oneself to becoming a teacher has similar stages of concerns which focus first on self, then on system, and finally on student learning. This research study findings suggest that the order of concerns is different as a preservice teacher commits his/her self to teaching. If this is so, then it has an importance in relation to the structuring of experiences and courses for learning for preservice teacher education students.

The findings of this study suggest that the order is self, student learning, and then the system. The structuring of experiences for learning for preservice teachers might be more educative or meaningful if directed to this revised sequence in order to more closely match the level of the subjects' thinking about teaching. Greater learning outcomes may result to give validity to the course and turn preservice teachers' simple views into more complex views of teaching. Further research is needed to document preservice teachers concerns as they commit themselves to teaching and their order of occurrence as related to course experiences.

A second conclusion to the issue of the nature of the teacher's work, was in relation to the framework of Schwab's (1969) four commonplaces. These sorted the subjects into groups who held either simple or a complex view of teaching. However, the analysis procedures used in this study failed to explain the relationship between the complex view and that of the effective teacher. Only two of the four complex pattern subjects had an adequate knowledge base about teaching to enable them to function with a high degree of cognitive consistency between their dispositional knowledge base for making judgements and their propositional and procedural knowledge base for making decisions about actions for effective teaching.

The second issue, the problem for course interpretation, pointed out the importance for a subject to have a sharp picture in mind of self as a teacher of a particular science content, in relation to defining an appropriate problem s/he would use for course interpretation, i.e. to solve in the course. Five of the subjects had course problems that were tangental to the methods course solution defined by goals and objectives for the course. Five subjects had problems that were related and indicative of their limited understanding of teaching as they began. Only two had problems which directly matched those used to define the course. This issue raised the question of whether or not the content of the methods course should be adjusted to fit the problems of the students, or the students should be screened or tracked in relation to their readiness for the course. The conclusion was that subjects with a good understanding of teaching as well as students with a very limited understanding of teaching were very limited in what they could learn from the course. Thus, a special "problems of teaching" may be an appropriate alternative to a methods course for students who have well defined concepts about effective teachers. A pre-methods course experience would be beneficial for those with a very limited understanding of teaching to establish mental conditions for use in interpreting a methods course more effectively.

The third issue, determinants of the curriculum, the conceptual patterns of the subjects points out the need for long-range as well as daily planning experiences as a part of the methods course. Five subjects believed that the textbook alone defined the curriculum. Two other subjects were unaware that situational factors were important for making decisions about course content. Effective and efficient decision-making is important in relation to student's learning outcomes and most subjects were very limited in understanding the relationship between long-range and daily instructional goals. Only three subjects were able to account for multiple internal and external factors related to the classroom in long range planning. Failure to do so by other subjects would influence how they would function in the real world as teachers making learning meaningful for students. The conclusion was that the methods course should provide students with an understanding of how they were accountable for student learning outcomes in their work. The relationship between daily and long-range goals, and the relationship of the educational system and public expectations in regard to their work results should be addressed in methods course instructional experiences.

The issues of an idealized and realistic role definition for the teacher had several significant conclusions. First, in relation to research methodology, the second purpose of this study, a conclusion was reached regarding the data analysis. It was found that during the interviews the different questions and tasks used required subjects to use different types of knowledge about teaching for responding. Subjects' responses defined definite sets of conceptual patterns about ideals or beliefs about teaching which were not always the same as those expressed when they functioned as a teacher in completion of teaching knowledge application level tasks. A conclusion in relation to methodology for analysis of data and future research efforts was that the dispositional, propositional and procedural knowledge bases for teaching are distinct within the individual's mental framework for teaching, and must be accounted for by careful structuring of questions and tasks. The research design of this study successfully isolated the dispositional knowledge base as an idealized view of teaching, but failed to delineate separate propositional and procedural knowledge bases of students. It did isolate the operationalizable knowledge of teaching for a subject as the realistic view of teaching, which was the combination of propositional and procedural knowledge about teaching a subject held. In future studies, unless specific propositional and procedural knowledge are being studied, the detailed analysis procedures of identifying essential elements of a lesson and frames for planning seem unnecessary. The descriptors based on implied roles for the teacher and students were directly determinable from subjects responses with an 87% agreement between independent coders reading of responses to application tasks.

A second set of conclusions related to the idealized and realistic views of teaching was that subjects, in all cases except one, had varying abilities to function in relation to the dispositional knowledge about teaching held. That is, most subjects knew more about teaching than what they could demonstrate in teaching task situations. The gaps in subjects' knowledge base for teaching existed not only between their understanding of teaching and that of an effective teacher, but also within their own mental framework. While the specifics of these gaps need further research efforts, this study identified the importance of concepts held about instructional goals, learning theory, and specific student characteristics for defining these gaps. The findings are viewed as a preliminary set of descriptors and numerical determinants scales for student and teacher roles which delineate how effective a teacher a subject would probably be. The particular underlying conceptual patterns about selection of learning activities, assessment of students, and engagement of students in a lesson were significant indicators related to teaching strategies. These descriptors and determinants proved to be a beginning base for comparing subjects, using their underlying concept problems in relation to teaching. Further work is needed to identify key misconceptions, or lacking conceptions subjects have as they begin a methods course to validate the relative scales for effective teaching produced in this study.

With regard to the data source it was concluded that the clinical interview was an adequate source for defining the subjects' dispositional knowledge base about teaching. The questions used in the interview provided adequate triangulation of data in regard to the dispositional knowledge base, but were inadequate in relation to the identification of separate propositional and procedural knowledge bases. Refinement and additional tasks addressing these two knowledge bases are needed in furture research efforts if an in-depth understanding of a subject's ability to function as an effective teacher is to be assessed by the clinical interview data collection method.

The plan and recall interview data set was swayed by some subjects using the course textbooks as a guide for writing the lesson plan, or the influence of the microteaching partner. This was a highly questionable source for inferring a subject's procedural and propositional knowledge base for teaching. It was concluded that the written lesson plan and thought recall did have potential for identifying the procedural knowledge base of a subject by using the planning frames and meanings' theoretical framework for analysis. With more specific and directed questions in the recall interview the data source could be useful to define the procedural, propositional and dispositional knowledge bases of a subject.

The microlesson data set had similar confounding variables problems as the plan and recall data set, for example, the variance in the groups of sixth grade students ramdomly assigned. Some subjects had students who were not fluent in English, while others had students with some previous experience in the content taught. The microteaching lesson did define the essential elements of a lesson, and the meaning given to them by the subject. However, it was a very subjective source for inferring the underlying planning frames and their meanings based on observable behaviors demonstrated in the lesson. With refinement of analysis procedures the microteaching lesson may be a reliable source for inferring conceptual patterns based on the essential elements of a lesson. However, in this study an inordinate amount of inference was required.

The overall conclusion in relation to the data sources was that the clinical interview with specific tasks was the best source for determining a subject's knowledge bases about teaching. For future studies the questions and probes used related to teaching tasks need to be modified to ensure triangulation across responses with regard to the specific propositional and procedural knowledge.

Implications

As presented in this study, if the goal conception of a teacher, defined by the expert, is the desired functional level for classroom teachers, then the findings of the study have implications as a line of continued research which is important in relation to spectrum of teacher development and assessment efforts issues. The essential findings were not different from the pilot study (Slinger and Anderson, 1983), although more definitive descriptors were developed for analysis in this study. This study suggests that a cognitive science theoretical research framework provide educational researchers with a means of documenting development of preservice teachers from experiences they encounter in preservice education and/or classroom experience using relative scale and directional development in relation to a definitive goal conception of effective teaching.

The findings suggest that although classroom teachers may not be cognizant of, or able to articulate, the importance of preservice education, a foundational knowledge about teaching, mental condition, is established which is used in the decision-making and judgment mental procedures of a classroom teacher's work. This documentable foundational knowledge is the mental framework for teaching. It may or may not be congruent with that of an effective teacher. Teacher actions are derived from the foundational knowledge about teaching held through decisions and judgments made which result in educational experiences for young people that may or may not instill, facilitate, or create a need for learning to occur within the individual students they teach. The implications of the findings are important in relation to developing efficient and effective mental frameworks for teaching in preservice students through course methods instruction, preservice teacher educational programs, inservice teacher development and evaluation systems.

Implications for a Science Methods Course

The findings suggest that students in a methods course have diverse and discrepant understanding about teaching. Course design must account for these if the instruction is to be educative for all students in relation to their development as effective teachers. From the findings, course goals should encompass those of science education as determined by society and the experiences necessary to reinforce the most effective learning outcomes of student achievement. This involves making clear to preservice teachers the need for continuous assessment of learning coupled with a decisive selection of activity options designed to maximize student learning. Both daily and long range planning mental planning procedures must reflect this knowledge for effective teaching.

The use of a preassessment instrument with methods course students would facilitate identification of the entry level mental condition of students in relation to effective teaching as well as defining the course problem of the preservice teacher. Feedback from such an instrument could maximize learning outcomes for preservice teachers and provide a justification for the design of course experiences which is directly associated with producing more effective classroom teachers. It would facilitate development of specific experiences to meet the needs of the students in a manner which accounts for their diversity in relation to becoming effective teachers. Career choice problems or concerns for the influences of the school system could be used to structure educational experiences which would facilitate each individual student's growth as an effective teacher. The goals and objectives for the methods course may not need to be changed. The challenge will be to accomplish the goals for all students in an approach similar to that used in the competency based teacher education program. The modification of instructional experiences would be rooted in a basic understanding of the thought processess and the knowledge base of the students instead of behaviorally focused responses, which may or may not be representative of what the preservice teacher understands about the complexity of teaching.

Implications for Preservice Education

There are several implications this study has in relation to preservice teacher education programs in general. Preservice teachers may have similar stages of concerns that they go through in the process of mentally committing themselves to teaching. Readiness for learning course content, mental conditions which would facilitate appropriate interpretation of course experiences, was not present in at least three of the twelve subjects of this study. Perhaps some type of additional experience prior to a methods course would assist preservice secondary science students with career decision focus problems and provide a more adequate and uniform entry level understanding of teaching for methods course students. The descriptors and determinants defined in this study may be used to define the directional changes which occur in preservice students in relation to becoming effective teachers at any point of the subject's preservice educational preparation program for teaching.

A second implication of this study's finding for teacher preparation programs is that the determinants may be a vehicle for identifying cooperating teachers for use in the student teaching experience. Such an·indentification system could prove helpful in the two dimensions of such placements. First, student teachers, such as Gary, may provide exemplary teaching for classroom science teachers who are identified as less than effective. Second, the descriptor and determinant scale would facilitate the matching of questionable or deficient preservice teachers with teachers who have a high degree of effectiveness. The descriptors delineate a specific set of criteria for use in assessing a teacher's effectiveness or preservice teacher's readiness for a program experience in a manner which uses the knowledge base of the individual as criteria. Thus, the determinants and descriptors are a method which may be used to document and test an educative experience for its effectiveness in creating conceptual pattern changes in preservice or inservice teachers.

Implications for Inservice Teachers:

The determinants defined by this study may be a useful set of criteria for defining teacher deficiencies and establishing inservice educational programs which have a justifiable base in relation to end results, or student learning in the classroom. If the goal of the educational system is to create learning in students, then teachers must have the knowledge base to be able to make decisions which results in alternatives for actions that are judged by a set of desirable and agreed upon ideals which result in effective and efficient use of classroom time for student learning. Teachers' accountability would have a definable basis with such an evaluation framework as outlined by this set of descriptors and determinants. The determinants are not restrictive in terms of individual style or teaching strategy, but function as parameters for professional decisions making and judgments similar to those used in other professions.

EPILOGUE

In conclusion, there are two questions this researcher wishes to add as points to ponder: 1) Are the set of descriptors and the determinant scales defined, representative of all teaching styles and delineated finely enough to adequately guide the directional development of preservice or inservice teachers? 2) Are the issues identified and used to define the descriptors the most important, or only a beginning base, for documenting an individual's understanding of teaching?

In relation to the descriptors and determinant's effectiveness this researcher has data from two sets of preservice secondary science methods teachers to use to assess what changes took place in the subjects as a result of the course. This dissertation defined the bases for documenting and analyzing such changes. As a footnote to the case studies, it was apparent in the follow up final student teaching reports that John was ill prepared to teach through his preservice experiences. He experienced multiple disciplinary and management problems and after ten weeks had achieved a level of teaching defined as a textbook teacher, or content authority presentor. Ray's report indicated that he was an effective teacher who would continue to learn from experience, while Gary was documemted as well prepared with multiple ideas to use to effectively engage students in purposeful learning. It was not clear in the final reports that Gary or Ray had acquired an applicable understanding level of the conceptual change learning theory.

In relation to the second question, an additional concern was to what degree does a secondary science teacher's content knowledge base influence their effectiveness as a teacher? To be a conceptual change teacher a detailed understanding of the nature of scientific knowledge and its formulation is required in order to determine appropriate instruction. This study did not address this discipline content knowledge base issue although the clinical interview responses of some subjects, and Dr. K., suggested that this was as crucial as one's teaching knowledge base. A second issue to be considered is the simple fact that no matter how much knowledge a person may have about something, such as effective teaching, there needs to be self or external rewards which motivates the individual to expend the extra efforts required to be an effective teacher. Without a doubt it is easier to assign the textboook and occupy students with paper work than to be an creative teacher who continually analyzes, diagnoses, and teaches as a conceptual change creator. As Gage (1978) says in THE SCIENTIFIC BASIS FOR THE ART OF TEACHING:

> "But, in the long run, the improvement of teaching which is tantamount to the imporvement of our children's lives - will come in large part from the continual search for a scientific basis for the art of teaching." p.41.

References for Chapter V

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Appendix A

1. Clinical Interview Schedule
2. Lesson Planning Recall Interview Schedule
3. Microteaching Observation Form

CLINICAL INTERVIEW INITIAL SCHEDULE

Interviewee code name: date and time:

I. BACKGROUND INFORMATION

(Probes anything from survey not clear)

Name

Major

Minor

Current Grade Level

Student Teacher When (term, year)

Reasons Teaching Career

Education Courses you've had? taking now?

Experience with Children / School?

II. CAREER GOALS

A. What influenced you to choose to be a science teacher?

B. What level and subject area yould you like to teach?

What kind of school district?

C. What do you imagine yourself doing 20 years from now?

III. SCIENCE TEACHING

1. Let's spend a few minutes talking about your feelings about teaching science.

    a. On a scale of 1-9 (low to high) how prepared do you feel to teach now? (If puzzled, if you were asked to take over a science classroom related to your major areas, how confident are you that you would do an excellent job of teaching?)

    b. In what ways do you feel that you are well prepared now?

c. In what ways do you feel you are not prepared now?

2. What do you hope to learn from participating in the science methods course?

3. Microteaching with 6th grade students is a part of the course. You act as an observer and a teacher as part of this experience.

   a. What are your concerns about microteaching?

   b. What do you think you will learn from the experience as a teacher? as an observer? any other?

   c. How do you feel about being observed?

4. In being a science teacher, what do you think will be your most important role?

IV. INSTRUCTION

1. Think of yourself as a science teacher

   a. Describe for me what you think would be a successful science lesson or sequence of lessons.

   b. What would an unsuccessful science lesson(s) be like?

   c. If you were a principal observing two science teachers how would you determine which was the better teacher?

2. In science instruction, what are the things that you would be most concerned about?

3. What are the most important problems that you anticipate as a science teacher?

V. PLANNING PROCESS

1. Think of yourself as a new science teacher in a school system of your choice. Describe for me how you would go about plan for instruction (Long term, monthly, unit, weekly, daily?)

2. In planning for daily lessons, what will you be most concerned about? (Night/weekend planning for Monday, what will you do?)

VI. NATURE OF STUDENTS IN RELATION TO TEACHER'S ROLE

Science often has a reputation for being a hard subject for many students.

a. Why do you think this is so or not so?

b. What kinds of problems do you expect students in your class to have in learning about (major area)?

c. What will you try to do as a teacher to make it easier for them?

THANK YOU FOR YOUR TIME AND HELP WITH THIS RESEARCH PROJECT

PLANNING RECALL INTERVIEW SCHEDULE

Name: Date and Time:
Lesson:

I. PLANNING PROCESS

1. What was your response to being asked to plan this microteaching lesson?

2. How did you go about doing this planning for your microteaching lesson?

3. What did you read? Order?

4. What information were you looking for?

5. What were your thoughts?

6. What did you learn from reading/recalling?

7. Did you refer back to anything? (materials, resources, thoughts?)

8. When did you start writing? What was sequence?

9. Did you have the plan fairly completely formulated in your head before started writing? What parts?

II. INSTRUCTION

1. Suppose you have to teach this tomorrow. Describe for me how you envision your plan will look when implemented.

   a. What will you do to begin this lesson?

   b. What directions will you give the class? (group formation, materials, discipline?)

   c. What would you do while students carried out your directions?

   d. How would you end the lesson?

2. How would you know if your lesson was successful?

(If you don't discuss objectives ask about what and how achieved)

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Microteaching Observation Form

Date________ Teacher________________ Observer____________________ Page___/___

Topic____ No. of 6th Graders in Group________

Time	Teacher Format	Materials St. Use	#	Students On Task	#	Students Off Task	General Notes
	Lecture Discuss Directions Demo Ind. St. Dead Time Transition Monitoring Other	None Sci.Mat. Worksheets Test/quiz Own Paper Puzzle/game Chalkboard Other		Listening Writing Sci.Mat. Talking Procedural Other		Nothing Talking Mis Behav. Other	

Time	Teacher Format	Materials St. Use	#	Students On Task	#	Students Off Task	General Notes
	Lecture Discuss. Directions Demo Ind. St. Dead Time Transition Monitoring Other	None Sci Mat. Worksheet Test/quiz Own Paper Puzzle/game Chalkboard other		Listening Writing Sci.Mat. Talking Procedural Other		Nothing Talking MisBehav	

Appendix B

Supplementary data of Case Study Subjects

1. Lesson Plan
2. Microteaching Descriptive Account

Lesson Plan - John

Objectives - to instill same knowledge of electric circuits

Activity	Time
Brief Discussion of Electricity	5 min
Demonstration with wires, battery & bulb	5-10 min
Student Activity with above	5-10 min
Discussion & Summary	Remainder

What can you think of in your house that runs with electricity?

Electricity needs to flow through circuits.

Circuits are like circles. The electricity needs to flow in circles. Positive to Negative, Negative to Positive.

Lesson Plan - Ray

Topic: Electrical Ciruits

Instructional Objectives:
1. The students will be able to write an operational definition of a circuit
2. The students will be able to find the circuits, and diagram them in a circuit puzzle.
— Introduce students and teacher.

1. <u>Content Item</u>
   What makes up a circuit?
— Equipment Needed:
   batteries, wire and a light bulb
— Instructional Strategies
   Students demonstrate knowledge of circuits
   T conducts Q/A for operational definitions
   — "What things are needed to make the bulb light up?"
   — "Can the bulb light up without the battery?" "Why?"
— Feedback Strategies
   Get — T asks students to demonstrate setting up a circuit. T takes a straw poll — "Is that right?" followed by Q/A.
   Give - T confirms some answers.
— Time Estimate: 2-8 minutes

2. <u>Content Item</u>
   Circuit Puzzles
— Equipment Needed:
   circuit puzzles, batteries, wire, light bulb, paper, and pencils
— Instructional Strategies
   T explains to students that puzzles contain circuits. Students are asked to find them using equipment used before. Students then draw what they think is in the puzzle. Afterwards, T shows them that puzzles are made of connecting aluminum foil.
— Feedback Stragegies
   Get — T asks "How" and "Why" the bulb lights at different part of each puzzle.
   Give - T praises good questions.
— Time Estimate: 10-15 minutes

3. <u>Content Item</u> (if time permits)
   Black Box
— Equipment Needed:
   black box, batteries, wire, light bulb
— Instructional Strategies
   Same as Circuit Puzzle item
— Feedback Strategies
   Same as Circuit Puzzle item
— Time Estimate: Too much — 10-15 minutes

Lesson Plan - Gary

Goal -
To familiarize the student to electrical circuitry

I. Written Objectives:
-- Identify closed and open circuits, given examples of each
-- Given a battery, wire, and an electric bulb, construct closed circuits in more than one way, to light the bulb and run the motor

II. Lecture (1:00 pm) Introduce Names - interact
On the board w/ lecture
(w/out bulb)
1. Battery - Energy Source (+ & -) charges
2. Wires - Analogy to water pipes: pump
3. Closed/Open circuits -
Make examples and ask questions

III. Lecture
Conversion of Electricial E to Light E and Heat E

(Feed back)

On the board - w/bulb

Discuss a circuit such that the flow of energy remains uninterrupted, thus the circuit will still be closed and make the light glow.

IV. Lab (1:10)

2. Prediction sheet II
3. Distribute material (except motor) - explain rubber band
1. Pair up kids

V. Observe and stimulate thought

VI. (1:20) Test Card II — Ask about 1st 3 boxes or 5 boxes

VII. Test Card II — draw 3 circuits

VIII. Wrap-up:

Review -
closed and open circuits
lighting a bulb in a closed circuit

IX. Other uses for electric energy besides light energy
- — mechanical energy
- — introduce motor and let them go

STOP - 1:25

X. Time - Flashlight

John -- Microlesson - Figure 1

Component	Teacher Actions	Student(S) or Students(Ss) Actions
Opening	Introductions among students and teacher	
	T "OK today I am going to try to teach you a little about electricity. So this is science. We're supposed to be teaching you something about science	Ss sit and listen
		S "Is it going to be fun things to do?"
	T "Sure we're going to have lots of fun things to do!"	S "Ah Good"
	T "Who can tell me something in their house that runs on electricity?"	Ss give individual answers going around table as called on by teacher
Lesson Set	T writes list on chalk board after each student response	
		Students tell teacher, "Your turn"
	T adds own answer to list and goes around one more time to students	
	T "OK that's enough..."	S interrupts with "I know one"
	T "Oh alright! What?"	"They got something that contains energy like it's a cooking pot that you plug in (S interrupted by teacher)
	T "Ya, there are a lot of cookers that you, those kind of fall under stoves. Yes. Well, that's enough of that"	
Activity 1		
Teacher Lecture	T "Uhm now, You know how electricity, you know how it has to flow. It runs through a circuit. You know electricity can't just go and stop." T waits for quiet	Ss talk to each other quietly as teacher lectures
		S "I know where it comes from."

Component	T Actions	S Actions
	T "Where does it come from?"	S "Sun"
	T "Well electricity doesn't come from the sun really. You get heat energy from the sun. Now, you know that like when you run a flashlight say, you know, OK there is a bulb..."	Ss Listen
Chalk Talk	T lecture continues topic: light bulb (drawn on chalk board), terminals (+&-) complete circuits = circle, switch = open & closed circuit	
Activity 2		
Students' Worksheets	T "OK Now I have a little exercise for you to try." Hands out worksheet and pens to students.	Ss comment. All talk freely One asks "Do we get to walk around?"
	T "Shh. Nope, you just have to sit for awhile."	S "Until it is time for us to go home?"
	T "For a little while. Ok now just try these, say these first three. Do one, two, and four. And try to draw in the wires, like if you were drawing in the wires, where would they go to make the light light up if you had to draw a circuit."	Ss begin worksheets S "Do we do from the bottom of the two or just?"
Transition	T answers students' questions and explains worksheet diagrams of bulbs to students. T monitors giving feedback "Yours looks real good, Joel"	Joel's next ones wrong and another student corrects. Ss talk with each other as complete worksheet
	T corrects Ss when he sees something wrong by lecturing to all students	

Component	T Actions	S Actions
	T "Here, I'll take these and now we can get on to some real fun stuff. I'll let you play with some real circuits."	
Transition		Ss comment excitedly with each other "That's the best. That's what I like" "Now it's the fun stuff"
	T (loudly) "Alright! Now we'll get out the circuits themselves and we'll let you make some circuits yourself."	
	T gets materials from his backpack on the floor	Ss comment as they watch, "Hey, hey, you got the rest of our things (materials) I hope."
Activity 3		
T demo complete circuit	T "OK now let's show you a little bit here about the circuits just what we said before. OK, here is the battery.. (continues to build explaining to students as he does).. It goes around but it doesn't touch anything"	Ss freely comment, interrupting teacher "Touch it!!"
	T continues to lecture on parts of light bulb, and which to put wires on bulb holder. He ends his lecture-demo with "And the outside touch on the outside which touches to that"	Ss talking
Activity 4		
Students manipulate materials to build circuits. T monitors	T "So let's see if you can make some circuits. I've got two of these so you can divide up and don't fight over it."	Ss comment freely as they get to play with materials from the teacher and begin to construct circuits.
	T monitors and comments on task occassionally to student "There she got it! Ya!"	

Component	T Actions	S Actions
	T spends most time with student without a partner.	
		S asks if electricity would hurt them.
	T "There is not enough electricity in a battery to hurt. There is not enough electricity involved that you can run that through your body. See, your body is not a good carrier of electricity. Hey! There you go S2. You can do it, see!"	
		Ss all comment when T compliments S2. S1 "I'll show you how I had mine."
	T monitors and assists S3	
		Ss start talking more and making silly comments like "Blow it out" S1 has it hooked up and it won't work and begins to complain to others
	T checks what S1 has and says "Now see you've got a short circuit..." explains with lecture	
		S1 interrupts T lecture asking "Does this thing (light bulb) get hot?"
	T "Oh, these light bulbs are so small that they won't get hot for a long time."	
		S3 "How come they make these yellow things to hold battery in?"
	T "So battery won't slide around	
		S1 gives own explanation for holder
T demo	T "These are just to make it easier... Here, I'll show you... (demonstrates using batteries without holder) And now if you touch, what are you going to touch to make the light bulb work?"	
		S2 "This here"

Component	T Actions	S Actions
	T "Can everyone see that? Will we have a complete circuit there?	
		S3 "Here and here" Ss continue to work with materials and talk. Some take battery out of holders.
	T "We leave them in there because it is easier to do it. It makes it more easily if you have something that you can hook up with."	
Off-task discussion 1 min		S2 "Can we walk around?"
	T "Nope, not yet" Teacher and student discussion about walking around building and partner teacher	
	T monitors, commenting "Now that would be a circuit if you had power, see..." (chalk board to draw)...	Ss working on building circuits
	Lectures on short circuit	Ss talking as T lectures
	T pauses for quiet	S3 tells others to "Be quiet!"
	T "Here S1, see if you can make a circuit. Start from scratch, and make one that will light the light bulb. See if you can do it."	S3 watching S1
		S2 "It's simple!" "Like what happens if I bust this (battery) on the ground?"
	T "It's a battery."	
		S2 "What would happen, though?"
	T "No, nothing particularly."	
		S1 "Would it blow up or something?"
	T "No, batteries don't really blow up."	
		S3 "What about if I just connect it together, like... (2 sets together)
	T "It will have the effect of making it a longer wire."	

Component	T Actions	S Actions
Off-task 1 min	Students ask teacher about next week's lesson, and discuss what others are doing today	
	T refocuses with compliment to S1	S1 "I know it."
1 min before end	T "All right, now I'll get out another little test for you here."	S1 "Alright I love tests!"
Activity 5 Worksheets	T hands out worksheet	Ss talk about tests
Time for Lesson Over -		
	T continues "It is almost time for you to go. Now, why don't you do those first few, and tell me how many you think will work?"	S3 "The first three?" S5 "Do we put Yes or No?"
	T "Just put a Y or N if you think it will make the light bulb light just like it is set up."	S2 "What if it's already done?"
	T "Oh, they are all already done. You're just supposed to tell Yes or No if it will make the light light."	Ss comment to each other as they do it.
	Questions back and forth between T and Ss about worksheet. Finally . . .	S3 "I don't get these pictures."
	T "Well, you don't have to do those. Just these first six is fine. These are with two batteries if we covered it. And they are dealing with short circuits and things like that."	S2 and S3 announce "I'm done."

Component	T Actions	S Actions
	T "Are you sure?" Checks paper and asks students questions	Ss confused and don't answer
Lesson Time Up and Teacher Interrupted - - - - - - - - - - - - - - -		
	T "We'll let him get ready for the next lesson."	
	T and Students leave room	

Ray — Microlesson

Component	Teacher(T) Actions	Student(S) or Students (Ss) S Actions
Lesson Set (Questions) (& T demo)	T "OK, ah, can anybody, did anybody learn anything from John?	
		Ss "Ya", "Yes" (convergent)
	Demo building circuit as asks students questions & check individuals	Ss respond to T's questions S1 "Uhn hun" S3 "Ya" S2 "Uhn hun"
		S1 "We learned that you need like two wires and one has to be on the bottom, very bottom of the light bulb and one has to be on the clip of it." S2 "Then it works cause they are both at the end of it. There ain't no where that it can power right into there."
	T "That's right. Do all three three of you feel that you know what a circuit is now?"	
Activity 1		
	T gives circuit materials to students & starts directions.	Ss build circuit tester. (They begin this before teacher can give them directions)
	T "OK, now wait!! What we're going to do is we're going to put this one..." Interrupted . . .	S "to this one and that one to that one."
Activity 2		
	T gets out circuit puzzle and holds T "OK, now take a look at these. We've got six dots. Now it's aluminum foil. Now, the idea of the puzzle is that you're supposed to connect each of these spots and see if the light works. Some of these	Ss with circuit testers listen to T

Component	T Actions	S Actions
	are connected. What you want to do is to tell me which ones are connected by which ones to make the light work."	
Modeling, Practicing Together	T - puzzle to students after showing one	1 student works circuit tester on puzzle - the others watch and freely comment.
Activity 3	T - gives data recording sheet to one S. Explains how to use. T "Why don't you draw a connected line between the ones that work?"	2 Ss continue to find complete circuits in puzzle as S1 asks, S1 "What do you mean a connected line?"
	T re-explains to S1 use of data sheet	
New Content Introduction	T - silently distributes puzzles to pairs of students	Ss work materials, testing puzzles for circuits
	T - monitors & after students find complete circuits T distributes data record sheet to group 2 and explains T "Write it down"	Ss in group do data sheet redoing circuit puzzle
	T - monitoring asking and answering students' questions	Ss data sheets & circuit testing
		S1 "How come, how's the foil letting it go through?"
	T explains (loud enough for all) "You see what these wires are made of? Wires are just metal. There's metal in here. And metals conduct electricity. And aluminum is metal. So there is aluminum connecting the dots."	

After approximately 10 minutes -

Component	T Actions	S Actions
Activity 4 Discussion of Data	T announces "OK, lets check them out" as removes circuit tester from students	
	T lectures on circuits from data sheets: S1's, then S2's and then S3's data sheets	Ss one at a time provide data sheets to teacher, answering his convergent question to confirm
	T opens puzzle to confirm after each. With S3's T has Ss hypothesize answer before opening. T opens; All hypotheses wrong	Students disappointed "Oh, I'm wrong" "We're all wrong" "I got shot down" "Dumb"
	T re-explains, concludes "There is just more than one way to do it"	
Activity 5 The puzzle as group	T gets circuit tester and demonstrates answer to S3's puzzle.	Ss take over testing for teacher Ss talk and play with materials as T checks for understanding
	T "OK, you understand that now?"	
		S3 "It goes right through the dots." S2 "but I think it might keep curving in."
	T "Right. A is going to connect to C by B. So when you connect A and C, you are connecting B also."	"Right", "Uhn hun", "Ya"
Activity 6 New Puzzle for practice together	T "OK, now look! Here is a trick one. Let's test this."	Ss test puzzle & give commenting on connected points
	T monitors and questions "How about D and B?"	Ss mixed Yes & No answers

Component	T Actions	S Actions
	T "OK, now just wait a minute. Do you think there is going to be anything across here? Do you think there is going to be a connection across here? and a connector across here?	Ss listen
		Ss predict "No it goes in that hole" "No, it has to go all the way around."
	T "All the way around what?"	
		"It has to go at least all the way around somehow like that in order to get there. Because if it just goes straight like that then it is not a circle."
	T explains how circuit is completed by foil "But the circuit is between the battery and the light. OK, what you're doing is imagining that this is just a chunk of the wire. OK, we've got different spots on here that may connect just like wires."	2 Ss work materials 1 listens to T's explanation
	T asks for new predictions "OK, what do you think which way is it going to go?"	S3 "All the way around around the top." S2 "I think it's going to be a triangle" S3 (inaudible response)
	T opens puzzle and explains to students	
		Ss confirm by retesting puzzles
Conclusion to Lesson	T "And so we're doing the same thing. We're connecting the circuit and we go from here to here OK, so electricity that is going through this wire through here, out to this wire, so we've got a circuit."	
		S2 "Oh"

Component	T Actions	S Actions
	T "See? You understand that?" and checks other 2 students	Ss begin to discuss a class field trip they'll be taking on Friday
	T tries to refocus with question, "What did you learn today? How to complete a circuit?"	
		"Ya" "And about the puzzle"
	T "Can you think of any circuits in your house?" so T ends 5 minutes early	Off-task, talking to each other

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Component	Teacher(T) Actions	Student(S) or Students(Ss) S Actions
Lesson Set	T questions students if have had some experience with electricity	
		S1 "Ya" S2 "No" S3 "No"
	"OK, with any kinds of wiring at all? or a class or something?"	
		S1 "No, but at home I take apart like, you know, old cars and stuff."
Activity 1 Q & A Transition	T "OK well that's really good. I'll tell you what, don't tell them (S2 & S3) all the answers. Let them figure it out. Ok S2, I think what we'll do basically is we'll let S1 work by himself, and we'll have the two of you work together and we'll experiment. And if you run into trouble, I can help you out, or maybe S1 can."	S2 off task and refocused by teacher
		Ss affirm quietly, "OK"
Activity 2 Q & A New Content Presentation	T at chalkboard. Objectives on board before class began T "OK, the first objective. To identify the difference between an open and closed circuit. OK now, with electricity, basically, we're going to start out with" (draws a battery on board)	Ss laugh at drawing and T joins in
	T "That's a battery" OK! OK! OK! Now, lets just depict this as a flashlight for a second, so everybody knows. What else do we have in a flashlight besides a battery?	
		Ss "Light", "Light bulb"

Component	T Actions	S Actions
	T "OK, how are we going to get the energy from this battery to this bulb?"	
		S1&2 "With a wire"
	T "With wires, OK. So that is basically what our circuit is going to be."	
		S1 "Circuits like an open circuit"
Activity 4		
	T continues brief lecture with drawings on chalkboard and asking students questions. Sequential development of content in lecture: 1) wire in circuit 2) start with battery has 2 poles (+ & -) 3) Energy 4) Circuit=flow of energy 5) Battery polarity 6) runs + to - through wire Ends lecture with water pipe and water pump analogy to explain open and closed circuits	Ss listen quietly and answer occassional teacher posed questions Ss listen
Activity 5 Q & A Application Assessment Practice with Feedback	Followed by application question TQ "Now, what happens if in this circuit we go ahead and replace this with our light bulb? Any ideas on what is going to happen? S2, what do you think?"	
		S2 "Uhm, (fidgeting) water's going to go in it
	T "OK, if that were another pipe versus a light, then it would, or it could. OK. So you still have a closed circuit. So what is this?" (points to board)	
		S2 "Battery"

Component	T Actions	S Actions
	Teacher continues to assess students for understanding with questions. After S3, T figures out S2 intentionally answering based on analogy so says, "Now we're talking completely on electricity so keep it in electrical terms."	Ss answer T questions
		S2 "OK" (smiling)
	T refocuses with another question	
		S2 answers correctly
	T "OK now, what is the whole system, S1?"	
		S1 "Ah, circuit"
	T "A circuit. OK now, is it an open or closed circuit?" (calls on each student to answer)	S1 "Closed" S2 "Closed" S3 "Closed"
Q & A	T continues to question Ss changing circuit, taking out bulb, etc.	
		Ss answer all correctly
New Content	T then builds to working with motor, explaining light and mechanical energy to students Questions them as goes. Builds content based on student answers to divergent questions For example, "What happens if I take this off of here and run it back to there?"	
		S3 "It won't work"
	T "Why?"	
		S3 "Cause you don't have the power."
	T "OK, that's really good. I see you guys are pretty sharp."	
		Ss discuss comment of T
Transition	T "OK, let's see if you are ready for action. I've got 14 minutes after. I guess we get started to get you out of here on time."	

Component	T Actions	S Actions
	T - Directions "OK, I am going to give you some materials and this is what I want you to do. I want you to take that battery and the light bulb and the wires I gave you, and I want you to find more than one way to make that bulb glow. OK S1, we'll have you work by yourself for a bit, and you two can work together." Distributes materials	Ss talk, asking where they can buy materials. Ss fight over material. S1 took a wire from S2 & S3
	T immediately settles problem over materials	
Activity 7 Building Circuits With Materials Practice with Feedback	T "You're fine. Let's just start out the plain old bulb first, and try to make a circuit so that it will work. Now remember where this has go to have a closed circuit for it to work. For the light to work... Don't watch old S1, he's doing fine. See what you can do."	
		S1 "They don't need to watch me." S2 and S3 have trouble getting started
	T helps - explains to use the diagram on board and some on handout given to students. Teacher tells "Now look at your diagrams here and see some of the wire patterns that they have. Now, you can try some of these. Now the ones that work, I want you to note that. I'll give you a pencil, so go ahead and start with your battery."	
		S2 and S3 work and start quietly singing

Component	T Actions	S Actions
	T checks on S1 - gives handout and directions. Monitors, asking and answering student questions, encouraging and reinforcing with praise and questions to individual students	Ss working with materials
		S1 gets circuit to work
Activity 8	T asks everyone to look and S1 "OK now, is there some special place that you have to touch on the bulb to get that circuit to work?"	
		S1 "Ya, cause look. OK here and it doesn't there." (demonstrates with circuit) Other Ss try and get theirs to work also
	T "OK now, try another way." then monitors	
		As students work, they discuss circuits and where to put the wires, and how energy flows.
Activity 9	Teacher tells S1 & S2 to "build it like a flashlight for me. Put the bulb right on top of the battery, just like a flashlight."	
		S2 and S3 are suprised when it works.
		After a while, S1 gets bored and starts singing
Individual Learning Needs Addressed	T "Here you go S1. I know you have a pretty voice. OK, just for fun here at the end, let's go ahead and go on to the motor so you can see how besides light energy you can get mechanical energy."	

Component	T Actions	S Actions
	T gives S1 the motor with reminders about, "You got to remember to always keep that closed. The second you open it up, it's gone."	S1 works with motor, building a circuit
	T helps S2 & S3 working on diagram circuits	
Activity 10 Q & A Assessment Application	About 5 minutes before lesson ends T announces "OK I'll just show you one last thing and we'll wrap this up."	
		S1 "This was a short experience."
	(loudly) "OK you guys. This is a fast, short circuit. OK now, use the flashlight and describe for me a closed circuit and an open circuit." T gives S2 a flashlight	
		S2 turns it on and says "Closed"
	T checks with other students	
		S1 "Closed" S3 "Closed" After several trials, S1 says "It's open and when it's on it's closed."
Activity 11 New Content	T requizzes them. Explains a switch to the students	
Summary Application	T has all students "grab each others hands"	
		Ss form circle with T
	Teacher has flashlight Directs and questions when hands together in circle = closed circuit and light on, etc.	
		Ss drop hands
	T "What happend when you dropped hands?"	
		Ss "Open" "Ya" "Do we get to leave right now?"

Component	T Actions	S Actions
	Teacher tells have second lesson	
		Ss work with motors in circuits

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