TEACHING FROM THE STUDENT'S POINT-OF-VIEW: A DEVELOPMENTAL PERSPECTIVE

by

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ABSTRACT

This study was an exploratory study of how teachers, when faced with classroom problems which are ill-defined problems, identify and interpret the student's point-of-view. The extent to which the concept of "teacher as problem finder" may describe those teachers who have the structures and strategies necessary for teaching from a developmental perspective was also examined.

The non-random sample consisted of 27 primary and intermediate level teachers who participated in district-sponsored in-service courses designed to introduce them to a developmental perspective on education. Participants were asked to complete 'The Student Anecdotes Task' and a questionnaire on their background and experience.

Teachers' responses to four questions which accompanied each anecdotal task were rated according to cognitive process variables associated with problem finding and subsequent problem solving. These included: problem formulation, integrative complexity, quality of point-of-view and developmental teaching strategies. Additional variables of interest to the study included, concern for problem finding and several demographic variables.

The results suggested that the variables of problem formulation, integrative complexity and quality of point-of-view as well as the developmental teaching strategies may affect how teachers identify and interpret the student's point-of-view in ill-defined problem situations. Implications for teacher education and studies of teacher thinking were discussed. The need for clinical interviews augmented by

classroom observations was emphasized for future studies. Several research questions, related to the cognitive process variables identified in this study to affect the teacher's ability to teach from a developmental perspective, were generated.

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There are those who adhere to
what's etched in stone;

There are those who question
what's etched in stone;

And then there are those
who question the stone itself.

-Author Unknown

To Patricia K. Arlin

For teaching me how to "...question the stone itself"

CHAPTER I. INTRODUCTION

This study is an attempt to describe how teachers, when faced with classroom problems which deviate from their expectations, identify the child's or adolescent's point-of-view. What is important to the present study is the idea that in order for teachers to implement strategies that guide students in the learning process through helping them with questions and problems from their own points of view, teachers need to be able to identify and interpret children's and adolescent's "alternate frameworks" (Driver & Easley, 1978), "reactions to failure" (Karmiloff-Smith & Inhelder, 1974), "faulty procedures" (Case, 1978, 1980), "incorrect" answers (Sinclair & Kamii, 1970), "unexpected" responses (Arlin, 1983) and "mismatches" (Elkind, 1976; Brooks & Fusco, 1983), or simply to understand curriculum tasks from the child's or adolescent's point-of-view (Elkind, 1976).

It will be argued within this study that in order to examine this view of "teaching for thinking" (Arlin, 1985), researchers need to explore "how the teacher understands the student's thinking and her role in their learning" (Lampert, 1984, p. 1). There is also the need for a problem finding or formulation framework to understand "how" the teacher formulates the problem of instruction based on her own experience and action. This framework may inform the teacher's own reflections on "how" a student "has a concept" (Larsen, 1977), and therefore reveal "how" the teacher "has the concept" of the "child's/adolescent's point-of-view" (Elkind, 1976).

A. BACKGROUND OF THE PROBLEM

Researchers have long maintained that the child is not a "miniature adult" and therefore reasons and learns differently than the adult (Dewey, 1933; Hullfish & Smith, 1961; Piaget, 1972, 1978). Interest has been primarily in identifying the processes of inquiry which are assumed to be associated with the kind of instructional intervention that meets the student's needs based on these differences.

In the Experimentalist tradition, Dewey (1933) identified an hierarchical model of problem solving which he called "reflective thinking" in order to describe the processes of inquiry which led to the development of knowledge. He emphasized that for reflective thinking to take place, the awareness of a problem and uncertainty about a solution to that problem must exist. Within this framework, he suggested that in order to successfully impart knowledge to students, there was a need for flexible teachers who had the ability to take advantage of unexpected incidents and questions in the classroom. This, he said, depended on the teacher's coming to the subject with freshness and fullness of interest and knowledge cultivated through the acquisition of attitudes which were favorable to the use of "reflective thinking". Dewey's emphasis on "reflective thinking" as an aim for education continues to influence research on teacher thinking, development and education (see Hullfish & Smith, 1961; Kitchener, 1983; Schön, 1983, 1987; Zeichner, 1983).

Recently, in the tradition of Dewey and in response to the expressed need for a developmental perspective on education (Glassberg & Sprinthall, 1980), many researchers (Glassberg & Sprinthall, 1980; Sprinthall & Sprinthall, 1983a, 1983b;

Thies-Sprinthall, 1984) have begun to incorporate a developmental framework, based on a combination of cognitive developmental theories (i.e., Hunt, 1961; Kohlberg, 1969; Loevinger, 1966; Perry, 1970; Piaget, 1972; Selman, 1980) into their studies of teacher development and programs of teacher education. Within this framework, the successful teacher is viewed as one who possesses the cognitive ability to engage in complex, flexible levels of thought which are seen as necessary for the development of the attitudes, behaviors and skills conducive to "reflective practice" and thus, the ability to teach students to think. These researchers state that, "we do not see it as a fallacy to suggest that if we know (tentatively) what development is then we may also know what education ought to be" (Sprinthall & Sprinthall, 1983b, p. 31).

What is problematic with these views of teacher thinking, is that the researchers neglect to consider the differences between child, adolescent and adult thought which go beyond "knowing that" there are differences to explain "how" these differences develop and "how" they affect the ways in which children, adolescents and adults construct their own knowledge and reality (Phillips, 1980). Conceptions of "the teacher as researcher" as they exist, do not consider the teacher's own construction of knowledge, do not respect thinking as a dynamic act of the teacher (Arlin, 1985), and do not indicate the theoretical frameworks or models which should inform the teacher's reflections. Rarely have the developmental constraints on the teacher's own thinking been addressed, particularly in terms of adult development (Arlin, 1984; Sinnott, 1981, 1983). Also, the teacher's own formulation of classroom problems has rarely been considered as critical to their subsequent problem solving.

Instead, teachers and their teaching continue to be examined through frameworks that assess "effectiveness" in terms of how well the teacher solves classroom problems in view of predefined definitions of "good" teaching practice. These frameworks tend to examine the teacher's ability to solve "well-defined" problems, and thus neglect to focus on "discovered" or "ill-defined" problems which also exist in the classroom (Dillon, 1982; Getzels, 1964; Getzels & Dillon, 1973; Mackworth, 1965). The processes of reflection teachers use to identify and interpret classroom problems as ill-defined problems have rarely been examined.

Many classroom problems are, in fact, ill-defined problems. They are situations where teachers, faced with students' "unexpected responses" to curriculum tasks, are required to identify the nature of each student's problem and seek its solution within the practical context (Arlin, 1983; Lampert, 1984; Schon, 1983, 1987). In these "ill-defined" problem situations the teacher constructs her own knowledge about the "child's/adolescent's point-of-view". The teacher frames the instructional problem and then proceeds toward a solution on the basis of how she has defined it (Arlin, 1983; Getzels & Csiksentimihalyi, 1976; Getzels & Dillon, 1973; Schön, 1983, 1987).

The dominant model in studies of "how" teachers think about problems of instruction and how they interpret these problems from the child's point-of-view (Arlin, 1983; Brooks, 1984; Brooks, Fusco & Grennon, 1983) is the Piagetian or Constructivist model (see Furth, 1981; Gallagher & Reid, 1981; Inhelder & Piaget, 1958; McNally, 1977; Piaget, 1972, 1978, 1979). This model attempts to explain "how" the thought and understanding of the child and adolescent differ qualitatively

from each other, and "how" the child and adolescent construct their own knowledge while acting on and interacting with the environment through mechanisms of construction defined by Piaget as the process of "reflexive abstraction". However, Piaget does not go beyond adolescent thinking to describe "how" it is qualitatively different from adult thought (Arlin, 1984). Uses of his model are, in large part, restricted to the teacher's own use of formal reasoning in "well-defined" problem situations (i.e., Smock, 1981). Piaget's concept of "reflexive abstraction" may, by analogy, be a very useful concept to describe teacher thinking, but it has not to date been used in such a fashion.

Neither Piaget's nor Dewey's conceptions of reflection attempts to describe the teacher's thinking in ill-defined problem situations. What is needed is a cognitive process model of teacher reflection which is analogous to the processes of discovery as they have been defined in descriptions of adult thought in general (Arlin, 1984; Neimark, 1982; Sinnott, 1981, 1983). Schön's process model of "reflection-in-action" (1983, 1987), informed by a "developmental perspective" (Arlin, 1983; Elkind, 1976) and a problem finding framework (Arlin, 1975-76, 1977, 1986; Getzels, 1964; Getzels & Csiksentimihalyi, 1976; Mackworth, 1965) may provide this model and thus a method for examining "how" the teacher "has the concept" of teaching from a developmental perspective.

B. STATEMENT OF THE PROBLEM

How do teachers identify the child's or adolescent's point-of-view when faced with classroom problems which may be described as ill-defined problems?

And to what extent does the concept of "teacher as problem finder" describe those teachers who have the structures and strategies available to them for discovering "how" a particular student "has a concept" in the practical context?

In order to examine these questions, teachers, participating in a series of workshops designed to introduce teachers to a developmental perspective, were asked to select and respond to one classroom scenario/simulation which represented the subject area and grade level most familiar to and/or taught by them. Each scenario, based on a teacher's own telling of a real-life classroom problem, represented an "ill-defined problem situation" for teachers in this study, and provided the stimulus for the question-asking task which accompanied each scenario. Four questions were designed to ask teachers about the nature of the problems and questions that students might have with certain instructional tasks presented to them for solution. Teachers in the present study were also asked to suggest possible strategies which might assist the students with their problems and questions. Criteria for rating how teachers identify and interpret the student's point-of-view when faced with ill-defined problem situations was developed from research on problem finding, cognitive development and reflective thinking.

There are three questions which arise from the problem statement. These are:

1. What kind of problem is a classroom problem?
2. What kind of problem does a classroom problem pose for the teacher?
3. What processes may be necessary for the teacher to begin to identify and interpret the student's point-of-view when faced with classroom problems which may be described as ill-defined problems?

These questions are the result of considering: (1) the kinds of problems teachers face in the act of teaching, (2) those classroom problems that can be called ill-defined problems, and (3) the teacher's own reflection-in-action when faced with classroom problems that are "ill-defined problems".

Each of these considerations will be discussed briefly in this Chapter and will form the framework for the review of the literature related to the problem addressed in this study.

1. The Kinds of Problems Teachers Face in the Act of Teaching

a. Kinds of Problems

Researchers (Dillon, 1982; Getzels, 1964; Getzels & Csiksentimihalyi, 1976; Mackworth, 1965; Wood, 1983) have differentiated between "well-defined" or "presented" problems and "ill-defined" or "discovered" problems. These problems and their processes of solution have been described along a continuum of "presented problem situations" and "discovered problem situations" each of which varies in what is known by the presenter and solver in the problem situation (Dillon, 1982; Getzels, 1964; Yinger, 1980). What differentiates well-defined (Mackworth, 1965) or presented problems (Getzels, 1964; Getzels & Csiksentimihalyi, 1976) from ill-defined or discovered problems in the present study is the nature of the problem of teaching itself, and the nature of the processes involved in identifying or formulating the problems of instruction from the "child's or adolescent's point-of-view". In this view, teachers need to employ a developmental perspective when they think about teaching.

This gives rise to the question, "What kind of problem is a classroom problem?"

b. The classroom problem

Researchers (Arlin, 1983; Brooks & Fusco, 1983; Yinger, 1980) observe that teachers, when planning lessons, attempt to anticipate students' responses to questions and difficulties within the lesson. However, many lessons still result in the "unexpected", where children or adolescents respond to curriculum tasks in ways that are "remarkably different from what the teacher would have expected" (Arlin, 1983). The observation that teachers often experience frustration "when students are unable to grasp the concepts they are expected to understand" is a classroom problem that is frequently articulated by teachers.

The following scenario is based on a teacher's own telling of an "unexpected" problem encountered during classroom instruction. It is one of several situations which will provide the basis for simulations of classroom problems used in the present study:

At the beginning of a new unit requiring an understanding of fractions, students in a grade 6 math class were asked the question, "What is a fraction?". They were asked this question after a review class on fractions. The assumption made by the teacher was that since most students are exposed to fractions as early as the first grade and build on this concept at each grade level, most students at the grade six level would already have a well-developed understanding of fractions and how to use them. These were some of the responses the teacher received from her students:

1. "The number on top is the number of pieces from the bottom."
2. "A math problem that might be solved in steps."
3. "A number over another number."
4. "Tells if something is even or not".
5. "Numbers that tell you different things like if a ruler looks just like a bunch of lines, its a bunch of fractions and you need to know them."
6. "Equal parts."

In this instructional situation, the students were presented with a conceptual problem after a review lesson on fractions. To this presented problem situation, each student brought her own repertoire of experiences and actions (Piaget, 1979), her own frame for understanding fractions (Arlin, 1986b; Driver & Easley, 1978; Erickson, 1987; Strauss, 1981), and the cognitive developmental processes she had available to her for constructing her own knowledge about fractions. In these examples, most of the students tended to define the concept of "fractions" in terms of their experiences with fractions. They were comprehending the teacher's questions on a literal level only. The students were constrained by the nature of the problem presented and by the cognitive mechanisms available to them for organizing the information.

This gives rise to the question of, "What kind of problem does this type of classroom situation pose for the teacher?"

2. Classroom Problems as Ill-Defined Problems

In the face of students' "unexpected" responses to what teachers believe to be well-defined curriculum tasks, the teacher who is not aware of the students' alternative conceptions, and who does not go beyond the students' "incorrect" answers to explore the "why" and the "how" (Arlin, 1985) of their responses, sees the students' answers as "wrong". She does not attend to the student's framework or point-of-view. Instead, she merely provides new information and examples of fractions which the students may simply layer onto their alternative conceptions through memorization (Brooks, 1984). Although the students may memorize the teacher's definition of fractions, often receiving praise for their "correct" responses,

what these students are actually doing is "masking" their own frameworks for constructing the concept of fractions (Arlin, 1986b). Teachers who look for ready-made solutions to students' problems tend to seek immediate closure for these problems. The problems students have with instructional tasks are "well-defined" for these teachers.

By contrast, the teacher who is aware of students' alternative conceptions allows herself to experience surprise, and recognizes that in these situations she is no longer able to use predefined methods or procedures to assist her students with their problems and questions (Schön, 1983, 1987). She recognizes the discrepancy between her own definition of fractions, the definition(s) she expected from her students and the definitions she actually received from her students. The teacher sees herself within a situation which requires further discovery and elaboration (Getzels, 1964; Getzels & Csiksentimihalyi, 1976), and realizes that "there is a problem in finding the problem" (Getzels & Csiksentimihalyi, 1976). For these teachers, the nature of the classroom problem is "unknown". The problem is "ill-defined".

No present teaching situation is exactly like a previous one, although there are features that they share in common (Schön, 1983). It is through reflection-in-action that the teacher extracts these common features and maps them onto "unexpected" situations. If these "teacher reflections" are informed by a "developmental perspective" (Arlin, 1983; Brooks, 1984; Brooks, Fusco & Grennon, 1983; Elkind, 1976; Feldman, 1981; Sigel, 1984; Sinclair & Kamii, 1970), which in turn informs the teacher's "reflection-in-action" (Schön, 1983, 1987), then the teacher may come to

know the logic that a child or adolescent brings to a particular curriculum task. Knowledge of this logic becomes the vehicle for the teacher's adaptation of instruction.

In the present study, students' "unexpected" or "unfamiliar" responses to what teachers believe to be "well-defined" or "presented" curriculum tasks, are "ill-defined", and act as a stimulus for the discovery-oriented processes of problem finding which lead toward the identification of the "child's/adolescent's point-of-view".

This gives rise to the question of, "How do teachers identify and interpret the student's point-of-view when faced with classroom problems which may be described as "ill-defined" problems?"

3. The Teacher's Reflection-in-action

Like traditional studies of teachers and their teaching based on "well-defined" problems and rational and logical explanations of "reflective thinking" (i.e., Dewey, 1933; Sprinthall & Sprinthall, 1983), Schön describes "reflection-in-action" as an on-going process of creativity and as a developmental mechanism of construction toward the construction of something new (Schön, 1983). Although similarities exist in these definitions, Schön (1983, 1987) goes beyond descriptions of thinking about one's own thinking (Lampert, 1984; Piaget, 1979) and thinking about doing something (Yinger, 1980), to "thinking about doing something while doing it" (Schön, 1983, 1987). His notion of the need for practitioners to engage in "reflective conversations with unique situations" may describe the teacher's reflection-in-action in ill-defined or discovered problem situations. It may also

describe the development of new concepts of teaching and learning which come through processes of discovering "how" the student "has a concept". The process of "reflection-in-action" may describe the teacher's own construction of the child's point-of-view when faced with classroom problems which are "ill-defined problems".

However, like Dewey, Schön, in describing his concept of reflection-in-action, does not adequately account for the kind of thought that is characteristic of adult thought in general (Arlin, 1984; Neimark, 1982; Sinnott, 1981, 1983); thought which is qualitatively different from child and adolescent thought (Arlin, 1984, 1986). In other words, there may be developmental constraints on the teacher's own thinking which are not accounted for in Schön's description of reflection and in his development of his theoretical framework. Schön does not suggest how the reflective practitioner acquires the theoretical framework through which she filters her experience. What may be missing in his description of reflective practice is a problem finding framework to inform the teacher's reflections in the first place.

4. The Need for a Problem Finding Framework

Like her students, each teacher brings to a problematic situation, her own frame for understanding the situation, and the cognitive developmental processes she has available to her for constructing her own knowledge about the situation. Arlin (1975-76), in her cognitive developmental model of problem finding, found a relationship between several cognitive developmental process variables and problem finding ability. In view of these findings, the extent to which the teacher identifies the classroom problem as an "ill-defined" problem and thus identifies the student's point of view, may depend, in part, on the cognitive processes and structures she

has available to her for "thinking-in-action" (Schön, 1983, 1987). She, too, may be constrained by the nature of the problem(s) presented and the cognitive processes available to her for organizing the information.

A problem finding framework, coupled with experience, which informs the teacher's reflections, may provide a way of describing the teacher who "reflects-in-action" (Schön, 1983, 1987). This teacher reflects on her own theories of teaching and learning, rather than appreciating and conforming to predefined problems, methods and solutions and religiously following lessons as outlined in teaching manuals (Arlin, 1983; Dillon, 1982; Getzels & Dillon, 1973; Schön, 1983, 1987). This framework may also help to satisfy the need to study the teacher as problem finder who identifies her own problems and methods and who seeks her own solutions to the "ill-defined" problems of instruction.

C. SIGNIFICANCE OF THE STUDY

The need for a "developmental perspective" and a problem finding framework to inform the teacher's "reflection-in-action" is particularly relevant to the study of teachers and their teaching, and to the development of teacher education programs.

Observations that teachers often experience frustration when students are unable to understand concepts that they are expected to understand is a common problem articulated by teachers attending professional development programs. Most workshop or in-service settings provide teachers with opportunities to discuss their instructional problems, and suggest techniques and strategies that may assist the teachers with these problems. However, upon return to their classrooms, many teachers experience

difficulty translating their newly acquired teaching strategies into practice.

If researchers begin to study the teacher as one who identifies her own problems and seeks her own solutions within the practical context, they may begin to understand "how" and "why" teachers perform as they do. If they begin to take the teacher's point-of-view into account when teaching teachers how to teach for thinking, they may begin to identify the problems and questions teachers have when faced with "unexpected" classroom situations. If they ask questions about the teacher's own problem(s), then they may begin to match teacher education curriculum to the needs of the teachers. In this view, teacher education will begin where the learner/teacher is rather than on where the researcher thinks the learner/teacher "ought to be". This study may provide one new means for assessing the teacher's point-of-view as well as the teacher's ability to assess the student's point-of-view.

D. DEFINITION OF THE TERMS

This is an exploratory study of the ways in which teachers identify the child's or adolescent's point-of-view when faced with ill-defined problems. Several terms are important for this study. They are defined below:

1. Problem Formulation refers to the extent to which the teacher identifies classroom problems as "ill-defined or "discovered" problems (Getzels, 1964).

2. Integrative Complexity refers to the extent to which the teacher formulates alternative explanations about how the student is thinking about a particular instructional task when faced with classroom problems which may be described as ill-defined problems (Schroeder, Driver & Steufert, 1967).

3. Quality of Point-of-View refers to the extent to which the teacher formulates "general questions" (Mackworth, 1965) based on her hypotheses about how the student is thinking. This represents the extent to which the teacher

identifies the student's point-of-view when faced with classroom problems which may be described as ill-defined problems (Arlin, 1975-76, 1977, 1986).

4. Developmental Teaching Strategies refer to the number of different strategies, which reflect a 'developmental perspective', that the teacher employs when she thinks about her teaching in ill-defined problem situations (Arlin, 1983, 1986).

In the present study, the extent to which the teacher identifies the child's or adolescent's point-of-view when faced with classroom problems which may be described as ill-defined problems is represented by "quality of point-of-view". The processes which contribute to the teacher's ability to ask "general questions" are represented by "problem formulation" and "integrative complexity". "Developmental Teaching Strategies" represent the number of different strategies that the teacher uses to assist students with the problems they identify the student as having in the first place. Together, these cognitive process variables may provide a way for examining the extent to which the concept of the "teacher as problem finder" describes those teachers who have the structures and strategies available to them for discovering the student's point-of-view.

In addition, teachers' responses to the question, "Why do you teach?", will be used to provide an insight into the teacher's concern for problem finding. And, a variety of demographic variables of interest to the present study will be considered. These include: years of teaching experience, subject(s) taught, grade level(s) taught, other positions or experiences requiring direct intervention with children or adolescents, reasons for participating in the inservice course, and familiarity with Piaget's work and its implications for classroom practice (see Appendix B).

E. SUMMARY OF THE PROBLEM

This study is an attempt to explore the ways in which teachers identify the child's or adolescent's point-of-view when faced with students' "incorrect" or "unexpected" responses to what the teachers believe to be well-defined instructional tasks. The teacher's reflection-in-action is thought to be be informed by a cognitive developmental and problem finding framework. These frameworks may provide an insight into the extent to which the concept of the "teacher as problem finder" contributes to the identification of teachers who are able to discover the student's point-of-view in the practical instructional context.

Chapter 2 contains a review of the literature pertaining to these research questions.

CHAPTER II. LITERATURE REVIEW

The present study was designed to explore, (a) how teachers identify the child's or adolescent's point-of-view when faced with students' "incorrect" responses to instructional tasks, and (b) the extent to which the concept of "teacher as problem finder" describes those teachers who have the structures and strategies available to them for discovering this point-of-view.

The present study draws heavily from two related traditions: Dewey's Experimentalist view and Piaget's Constructivist view. It represents a unique combination of these traditions by redefining classroom problems as ill-defined problems. To understand a classroom problem as an ill-defined problem, research studies related to problem finding are introduced which in themselves tend to ignore the Deweyian-Piagetian traditions. Finally, within this framework, the teacher as problem finder is discussed in an attempt to describe the type of "reflection-in-action" which is conceived of in this study as the basis for teaching from a developmental perspective.

A. IMPLICATIONS FOR EDUCATIONAL PRACTICE OF DEWEYIAN AND PIAGETIAN THEORIES OF KNOWLEDGE

Researchers have long considered the child to be the centre of the education process (Dewey, 1933; Hullfish & Smith, 1961; Piaget, 1972, 1978, 1979) and have emphasized the idea that there are qualitative differences between how children and adults think. Much research has focused on the ways in which these differences in thinking influence the competence of teachers as they interact with their students

daily in the classroom. The processes of thought teachers use to identify and solve problems of instruction in ways which meet the needs of the students are primarily based on theories of growth in knowledge or reflection espoused by Dewey (1933) and Piaget (1972, 1978, 1979). These two traditions will now be discussed as they relate to the research problem.

1. Dewey's Experimentalist View of Growth in Knowledge

Dewey (1933) maintained that the child reasons and learns differently than the adult. He believed that the problem for the student was found in the subject matter, and that the problem for the teacher was "what the minds of pupils are doing with this subject matter" (Dewey, 1933, p. 275). In this view, Dewey (1933) emphasized the need for teachers who had the capacity to "learn how to think well, especially how to acquire the general habit of reflecting" (p. 35). He saw this "mental habit" as essential to the teacher's ability to teach with intent, to observe and interpret the intelligent reactions of his/her students, to approach each subject with interest and knowledge, and to be acquainted with the principles of educational psychology (Dewey, 1904, 1933). This, he said, required the attitudes of "responsibility", "openmindedness", and "wholeheartedness" displayed by the teacher in the classroom.

In order to provide a way to describe "how" teachers attain the attitudes, behaviors and skills associated with "reflective practice", Dewey (1933) identified an hierarchical process of problem solving which he called "reflective thinking". He maintained that reflective thinking was initiated after the recognition of a "true" problem and ended with a judgment. The individual's awareness of a problematic situation was referred

to as the "prereflective stage" where "uncertainty" made the situation genuinely problematic and therefore initiated the process of "true inquiry". Dewey stated that this process of inquiry or reflective thinking was guided by "critical inquiry" and was informed by experience, where each new experience "takes up something from those which have gone before and modifies in some way the quality of those which come after" (Dewey, 1933, p. 27). For Dewey, this process of inquiry ended in a judgment where the individual identified a solution to the problem or at least temporarily closed the issue. He argued that knowledge was an outcome of the process of inquiry which led toward truth because the method itself implied the continuous verification of beliefs, assumptions, and hypotheses against reality.

In Dewey's analysis of reflective thinking (Dewey, 1933; Kitchener, 1983), he indicated five phases of critical inquiry to explain the processes of thought that individuals use when faced with problems that are real and meaningful to them: (1) Suggestion, (2) Intellectualization, (3) Hypothesis, (4) Reasoning, and (5) Hypothesis Testing. "Suggestion" was the immediate identification of and weighing of possible solutions. "Intellectualization", for Dewey, was the clarification of the specific problem. The "Hypothesis" was the development of a supposition or suppositions which acted as a guide to the collection of observations. Then "Reasoning" occurred about possible consequences of action on the hypotheses and the further development of better and more complete explanations. And finally, the hypotheses were tested by action (direct observation or experimentation) which might lead to the formulation of a second, better hypothesis (Dewey, 1933; Kitchener, 1983).

Dewey's theory of knowledge or reflection, when applied to teaching practice, suggests that teachers, when faced with "uncertainty" in the classroom setting, must formulate ideas about a solution to the problem and collect evidence which may verify or refute some of their original ideas and expectations. Then, in an orderly fashion, they must develop an hypothesis, and based on the hypothesis, make a judgment or decision which provides an answer to the question at hand or which remains open to further inquiry (Kitchener, 1983).

Dewey's emphasis on the teacher's ability to engage in the processes of critical inquiry and reflective thought eventually led researchers to determine what they perceived as the behavioral qualities of a "reflective teacher". This marked the beginning of research incorporating the attitudes of the behavioral and social sciences into methods of observation for gathering information about human behavior for the purpose of predicting "effective" teaching behavior and "competent" teachers. This gave rise to the "inquiry-oriented" approach (Zeichner, 1983) and the cognitive developmental approach (Glassberg & Sprinthall, 1980; Sprinthall & Sprinthall, 1983a, 1983b) to studies of teachers and their teaching. These two approaches, representing the application of Dewey's theoretical and philosophical views to teaching practice, will be briefly reviewed.

a. The Inquiry-Oriented Approach

The central aim of the inquiry-oriented approach to teaching, based directly on Dewey's (1933) theoretical views of knowledge and "reflective practice", was to incorporate "habits of inquiry" into teaching practice (see Bagenstos, 1975; Elliot, 1976-77; Feiman, 1979; Goodman, 1984; Joyce, 1972; Oja & Ham, 1984; Salzillo &

Van Fleet, 1977; Stratemeyer, 1956; Zeichner, 1981). Teachers were defined as "active agents" who exhibited the skills and desire to analyze the effects of their actions on children, schools and society based on questions about what "ought" to be done (Zeichner, 1983). The primary task for the teacher was to attain the ability to engage in some form of "reflective activity" as defined by Dewey (1933), and to develop a "disposition toward critical inquiry" (Zeichner, 1983).

b. The Cognitive Developmental Approach

In the tradition of Dewey, and in response to the expressed need for a developmental perspective on education (Glassberg & Sprinthall, 1980), some researchers (Glassberg & Sprinthall, 1980; Sprinthall, 1983a, 1983b; Thies-Sprinthall, 1984) began to incorporate a cognitive developmental framework based on a variety of developmental domains (i.e., Hunt, 1974; Kohlberg, 1969; Loevinger, 1966; Perry, 1970; Piaget, 1972; Selman, 1980) into their studies of teachers and their teaching. In view of Dewey's (1933) definition of education as an active process of continual growth, and the assumptions of cognitive developmental stage theory, these researchers (Glassberg & Sprinthall, 1980; Sprinthall & Sprinthall, 1983a, 1983b) designed programs of teacher education based on the rationale that, (a) teachers, whose behaviors are associated with higher cognitive domains and higher stages of development, "function more complexly, possess a wider repertoire of behavioral skills, perceive problems more broadly, and can respond more accurately and empathetically to the needs of others" (Sprinthall & Sprinthall, 1983b, p. 21; Walters & Strivers, 1977), (b) adults continue to develop, particularly in areas of problem solving, generalization and concept formation (Sprinthall & Sprinthall, 1983b), therefore (c) teacher education programs can be designed to promote teachers' cognitive

thought processes toward higher, more abstract levels of complex and flexible thought (Sprinthall & Sprinthall, 1983a, 1983b). In sum, these researchers state that, "we do not see it as a fallacy to suggest that if we know (tentatively) what development is, then we may also know what education ought to be" (Sprinthall & Sprinthall, 1983b, p. 31).

What is problematic with the inquiry-oriented and cognitive developmental approaches to the study of teachers and their teaching is that the stress is on the teacher appreciating and conforming to definitions of important problems identified by researchers, and on the effects of the teacher's observed behaviors on student growth and achievement. They do not place the stress on the teacher, who both defines the problem and seeks its solution within the practical context. Instead, researchers, based on their own theories and hypotheses, identify and interpret "how" teachers "ought to" go about solving problems of instruction and learning in the classroom by identifying the behaviors, attitudes and skills deemed necessary for teaching children to think. Methods and techniques of teaching based on pre-defined definitions are indicative of researchers' neglect to consider the inter-individual and intra-individual differences in child, adolescent and adult thought which go beyond "knowing that" there are differences to explain "how" these differences develop and "how" they affect the ways in which children, adolescents, and adults construct their own knowledge and reality (Phillips, 1980).

2. Piaget's Constructivist View of Growth in Knowledge

The dominant model in studies of how teachers think about problems of instruction from the child's or adolescent's point-of-view (Arlin, 1983; Brooks, 1984; Brooks, Fusco & Grennon, 1983) is the Piagetian or Constructivist model (see Furth, 1981; Gallagher & Reid, 1981; Inhelder & Piaget, 1958; McNally, 1977; Piaget, 1972, 1978, 1979). The Piagetian model attempts to explain "how" the thought and understanding of the child and adolescent differ qualitatively from each other, and how the child and adolesent construct their own knowledge while acting on and interacting with the environment. Piaget's constructivist view of development provides a useful starting point for the development of a framework for studying the ways in which teachers deal with problems of instruction in their classroom. This next section examines some of the contributions of Piagetian theory to educational practice and how these contributions apply to the research problem.

a. Toward a Constructivist View on Educational Practice

Like Dewey and the Experimentalists, Piaget saw the role of experience and action as important to the development of thinking. Piaget stated that the child or adolescent needs to build up a repertoire of experience and actions on objects, upon which they can reflect and out of which they will ultimately build concepts (Piaget, 1978). A key concept in Piaget's epistemological view of education is that of "reflexive abstraction" (Furth, 1981; Gallagher, 1977; Gallagher & Reid, 1981) which represents one of the mechanisms of cognitive development. It is a means by which children and adolescents construct or invent their own understandings of the world. For Piaget, this describes the child's reflection-in-action which leads to concept development. Although both Dewey and Piaget focus on processes of

problem solving in their theories of knowledge growth, it is Piaget's emphasis on the "mechanism" of growth which differentiates Dewey's descriptive theory of reflection from Piaget's constructivist theory of reflection.

In order to explain this mechanism of construction, Piaget identified two types of action that children use to construct their own knowledge and understanding. These actions result in physical knowledge and logico-mathematical knowledge. Physical knowledge represents one's knowledge of the physical properties of the external world. Logico-mathematical knowledge represents knowledge derived from thinking about one's own experiences with objects and events. This second type of knowledge also includes structures for organizing, constructing and transforming empirical data, and therefore becomes the framework into which physical knowledge is integrated and therefore given meaning.

The process by which individuals acquire physical knowledge is called "empirical abstraction". This process is based on concrete, physical observables and on the individual's actions on those observables. By contrast, the process by which individuals acquire logico-mathematical knowledge is called "reflexive abstraction". This process is based on the presence of abstract mental structures. For Piaget, further growth in knowledge means to go beyond the observables or "beyond the information given" (Bruner, 1973), where the individual constructs her own "rules" through the mechanism of reflexive abstraction. Contrary to Dewey's hierarchical stage progression, "[r]eflexive abstraction does not 'replace' empirical abstraction, but frames it from the start and then goes infinitely beyond it..." (Gallagher & Reid, 1981, p. 29). In other words, the developmental level an individual has attained

only puts constraints on her maximum performance within particular situations (Arlin, 1984; Biggs & Collis, 1980). It is this "interplay" between empirical abstraction and reflexive abstraction that is the basis for the following implications of Piaget's theory to educational practice:

Reflexive abstraction has two characteristics. First, it is characterized by a projection from a lower level to a higher level in the physical sense which provides links between and among experiences of the individual from infancy onward. For Piaget, this "mirror reflection" represents a movement from being able to do something (the actions level) to thinking about doing that thing (the representational level). The individual is now able to reflect on previous actions and to build concepts out of these reflections.

Secondly, reflexive abstraction is characterized by a mental reorganization or reconstruction of knowledge at a higher level. Here, the individual is not merely reflecting onto a higher level, but is reconstructing on that higher level, which is enriched with new elements, what already existed on the lower level. Unlike Dewey, who identified a uni-lateral theory of problem solving based on five steps of thought, Piaget was more interested in the development of cognitive structures where "[p]roblem solving would,...,be regarded as fundamentally the operations of the operative aspects of thinking" (McNally, 1977, p. 85). For Piaget then, "[g]rowth in knowledge at all levels is the constant spiral of projection and reorganization, then another projection and reorganization, and so forth" (Gallagher, 1977, p. 9) which leads to the development of the mental structures which characterize one's level of thinking. Piaget's constructivist view of child and adolescent development

led to the expressed need on the part of some researchers (Elkind, 1976; Feldman, 1981) for "...all education, all teaching--no matter where or of what kind--[to be] based upon a theory of child development" (McNally, 1977, p. 84). In this view, teachers who reflect on their own theories of teaching, learning, instruction and education may take their student's point-of-view into consideration while they teach. However, Piaget did not address the problem of adult cognition, nor did he attempt to use his concept of reflexive abstraction to discuss "how" professionals translate theory into action.

b. The Teacher as Developmental Psychologist

Elkind (1976) and Feldman (1981) speak of the need for a developmental perspective on education, however, neither provides an operational definition of this perspective. Elkind's (1976) description of the important role that a theory of child development plays in classroom practice makes a substantial conceptual contribution toward such a definition.

Elkind (1976) saw "effectiveness" in teaching as the teacher's ability to take "the child's point-of-view", that is, to see students' difficulties with instructional tasks from the child's or adolescent's own perspective. Unlike the Experimentalists, he made the suggestion that the primary contribution of child development research to education is not in the prescription of methods and specific learning principles, but rather in assisting teachers to look at classroom tasks in terms of a "developmental perspective". A further contribution is in the provision of techniques whereby students come to reveal their thinking to teachers, and teachers, on the basis of these revelations, adapt the logic of tasks to the logic of students:

> ...one of the most important contributions child development can make is not so much particular contents and principles of learning, as a general orientation towards children. What the developmentalist has to offer the teacher is first and foremost a developmental perspective and techniques for exploring the child's own view of reality. (Elkind, 1976, p. 53)

From this view, teachers, informed by a theory of child development begin to think about the child's or adolescent's thinking while planning and implementing instruction and may begin to take this thinking into account as they teach (Arlin, 1983, 1985; Brooks, 1984; Brooks, Fusco & Grennon, 1983). They may ask questions about that thinking in relation to their plans and materials (Brooks, 1984; Brooks & Fusco, 1983; Yinger, 1980). They may also question it when faced with difficulties students often display when presented with new concepts or with concepts which they do not understand (Arlin, 1983; Case, 1978, 1980; Elkind, 1976; Grennon, 1984; Strauss, 1981). In the constructivist view, the teacher is no longer an "object" to be studied and manipulated by researchers, but rather becomes an active participant who defines and interprets her own problems and questions in the practical setting. In so doing, the teacher is actively engaged in constructing her own theories of teaching and learning (Arlin, 1983, 1985; Lampert, 1984; Schön, 1983, 1987). They become researchers in the classroom.

c. Teachers as Researchers

The construct of "teacher-as-researcher", while not a new construct (see Hullfish & Smith, 1961; Sprinthall & Sprinthall, 1983a, 1983b; Zeichner, 1983), has recently been redefined (Lampert, 1984) within a project designed to bring teachers and educational researchers together to recognize the intuitive knowledge of children, and in light of this recognition to explore together how the appreciation of this

intuitive knowledge could be useful in educational practice (Lampert, 1984).

Lampert (1984) presents ways in which classroom teachers might interpret and respond to questions raised by students. She redefined the teacher's work to include "on-the-spot clinical research" into the way a learner thinks about something. This provides the opportunity for suggesting an appropriate place for the teacher to begin her lessons. She speaks of the teacher's ability to "think about one's own thinking" and how this affects the interpretations and responses of the questions children ask, which she says depends on "how [the teacher] understands children's thinking and her role in their learning" (Lampert, 1984, p. 1).

What is problematic with this conception of the teacher and her teaching is that it continues in the Experimentalist tradition in that "the project sought to bring teaching practice closer to the work of researchers trying to understand how children learn" (Lampert, 1984, p. 2). Again the stress is on the teacher appreciating and conforming to definitions of what researchers consider to be important problems of teaching, learning, instruction and education.

The theories, models and research findings from the constructivist and experimentalist fields of inquiry form a framework from which the teacher can view teaching, learning, and the child's own construction of knowledge within the classroom as she constructs her own knowledge of teaching. A framework which provides opportunities for teachers to reveal their own thinking about teaching, learning, instruction and education needs to be developed in order for researchers to explore the teacher's own reflection in the face of classroom problems.

B. A FRAMEWORK FOR EXPLORING THE TEACHERS' OWN CONSTRUCTION OF KNOWLEDGE

1. The Kinds of Problems Teachers Face in the Act of Teaching

Researchers have differentiated between "presented" and "discovered problems" (Getzels, 1964; Getzels & Dillon, 1973; Getzels & Csiksentimihalyi, 1976) and "well-defined" and "ill-defined problems" (Mackworth, 1965). The "presented" or "well-defined problem" has been described as a situation where an individual is presented with a problem which is solvable through some known or identifiable method or procedure. By contrast, the "discovered" or "ill-defined" problem has been described as a situation where the individual finds herself faced with a problem for which there is no immediate or known solution. These problem types and their corresponding processes of solution are described along a continuum of "presented" and "discovered" problem situations each of which varies in what is known by the presenter/teacher and solver/students in the classroom situation (Dillon, 1982; Getzels, 1964; Yinger 1980).

Classroom problems have traditionally been treated as "presented" or "well-defined" problems where teachers are given the methods and formulas for solving classroom problems and are expected to incorporate these predefined strategies into their classroom practice (Brooks, 1984; Dillon, 1982; Getzels, 1964; Getzels & Dillon, 1973; Schön, 1983, 1987). In this view, "discovery-oriented problems" are often treated as "presented problems" where teachers and researchers neglect to gather further information about the problematic situation (Getzels, 1964). They neglect to gather information from the student's point-of-view.

2. Classroom Problems as Ill-defined Problems

Many classroom problems are, in fact, "ill-defined" or "discovered" problems. They are problems which teachers identify and interpret as deviating in some way from their initial expectations of teaching and learning (Schön, 1987). They are situations where teacher's recognize that a student's "unexpected" or "incorrect" response contains a wealth of information about "how" that child or adolescent is thinking about a particular concept or task. In these "discovered" or "ill-defined" problem situations, teachers need to recognize that further discovery and elaboration are required, and that even after a solution is attained, the problem is still largely unidentified (Getzels, 1964; Getzels & Csiksentimihalyi, 1976). This provides opportunities for teachers to identify the student's methods for arriving at a response, that is, to identify the child's or adolescent's point-of-view. In this view, researchers are able to explore the teacher's own construction of knowledge by providing opportunities for teachers to reveal their own thinking about teaching learning, instruction and education.

Two classroom scenarios, as examples, can show how teachers begin to identify the "child's/adolescent's point-of-view" when faced with classroom problems which may be described as ill-defined problems. These scenarios, based on teachers' own tellings of actual classroom problems, provide the framework for the development of the classroom simulations used in the present study (see Appendix A).

Scenario #1:

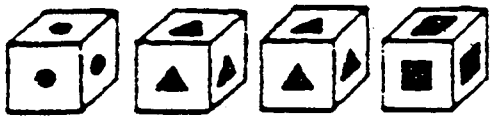
Researchers have expressed the need for teachers to formulate "on-the-spot" hypotheses into the way a child is thinking about something (Karmiloff-Smith &

Inhelder, 1974; Lampert, 1984), and for practitioners in general, to generate hypotheses as part of the exploration that comes with "reflection-in-action" (Schon, 1983, 1987). This gives rise to a strategy of "hypothesis generation" (see Arlin, 1986b).

Two third grade teachers (H. Jelke & C. Reynolds, personal communication, October 1982) discuss their experience with a statewide arithmetic pretest (see Arlin & Levitt, 1986). They begin their analysis by taking note of the test questions which were most frequently missed by their students. Figure 1 shows a sample item with the teacher's notations:

Figure 1: Teacher Notes for Analysis of Pretest Item

61. Which fraction shows the probability of picking a block with triangles on it:



a) 1/2 ////

b) 2/4 ~~////~~ /

Three triangles per block and four blocks?

c) 3/4 ~~////~~ ~~////~~ /

d) 4/4 no ans. ~~////~~

The following information was discussed:

While "b" or 2/4's was the correct answer from the adult's point-of-view, these teachers observed that the most popular answer for the children was "c" or 3/4's. In view of this discovery, they asked themselves the question, "How could 3/4's be chosen as the "right" answer?" One teacher looked at the 4 blocks and noted that there were 3 triangles per block and that there were 4 blocks in the picture (see Figure 1). From this, she asked herself the question, "Was it possible that the children simply related a part to a part, 3 to 4, rather than a part to a whole, 2 out of 4 blocks had triangles?" This second question is a type of educated guess or informal hypothesis which is generated by the teacher. With this hypothesis in mind, the teachers then asked their students to tell them how they made their choice of 3/4's for an answer. The students provided them with a type of "hypothesis confirmation" by explaining that there were three triangles on a block and that there were four blocks, so of course the answer was 3/4's. Had the students not confirmed the teachers' hypotheses, the process would have continued until the hypothesis was verified or refuted or until no further information could be gathered from the students.

These teachers, through the use of the hypothesis generating strategy, drew upon Sinclair and Kamii's (1970) comment that, "children correctly answer the questions they ask themselves". In these situations, it is up to researchers to discover precisely what teachers think that question is (Arlin, 1983). In the present scenario, the teachers, in generating their informal hypotheses, considered the children's "wrong answers" and asked themselves the question, "For what question is this wrong answer, in fact, a right answer?". With this question, the teachers began the

process of identifying the problems the students were having with the curriculum tasks and materials from the "child's point-of-view" (Arlin, 1983). Here, Piaget's clinical method became the instructional method.

Scenario #2:

When teachers introduce new concepts to students, the most common questions that are asked to elicit the student's framework or point-of-view are: "What do you know about...?" or "What is...?" This strategy, which will be called "framing", has been discussed as a way for teachers to identify childrens' naive frameworks or points-of-view for certain concepts before attempting to teach these concepts (Arlin, 1986b; Erickson, 1987; Strauss, 1981).

A seventh grade teacher (see Arlin & Levitt, 1986) modified this developmental teaching strategy by framing a particular question on the basis of the science unit she was beginning on the solar system. She asked her students,

> Why do you think we always see the same side of the moon from the earth?

These are some of the responses she received from her students:

1. "Because when we rotate we are always in the same position every night".
2. "Because we move at the same time and speed as the moon does and that's why".
3. "Because the moon is moving with us".
4. "One side is facing space and we get stuck with just one side".

The teacher was amazed to find that there were 14 different points-of-view expressed among 42 students. Upon further examination of her students' responses, she found that half of them could be put into one general category to describe their basic frameworks. Nearly 80% of the students' responses could be placed in one of five categories.

This teacher (N. Darling, personal communication, May 1984) interpreted her students' points-of-view as, "I think these youngsters believe that the moon is in the same relative position all the time (a fixed object)". She goes on to describe her conception of the second most popular framework as, "I think that these youngsters believe that the moon goes to the other side of the earth (out of sight) during the day (even during the new moon)". This teacher's knowledge of "how" and "why" most of her students have "alternate conceptions" about the earth-moon relationship, directly influenced the types of examples and experiences she subsequently selected in order to talk about "tilt", "orientation", "relative motion" and "rotation" in relation to concepts of day, night, seasons, eclipses and phases of the moon. Here the teacher put into "explicit, symbolic form" the strategies which made up her "theories in action" (Schön, 1983, 1987). In this classroom situation, the teacher, faced with an ill-defined problem situation, verified her hypotheses about the students' problems by asking questions which elicited ongoing responses from the students' points-of-view. To determine the extent to which the teacher identifies the child's point-of-view in the face of ill-defined problems, researchers need to consider the question, "What questions do teachers ask their students in order to elicit students' responses about how they have a given concept?

In both of these instructional situations, the students were presented with a curriculum task by their teachers. To these presented problem situations, each student brought her repertoire of experiences and actions, her own frame for understanding the concepts and the cognitive developmental processes she had available to her for constructing her own knowledge about the concepts. In both of these examples, the students tended to define the concepts taught to them in terms of their experiences with the concepts and in terms of the physical characteristics of the concepts. They were comprehending the presented problems and questions on a literal level only. They could not understand and therefore could not describe what the concept was in a way that matched the teacher's own definitions. The students were constrained by the nature of the problem presented and the cognitive structures available to them for organizing the information. This provided an unexpected situation for the teachers who then attempted to identify the students' constraints in order to find a starting point for further intervention.

These descriptions of the strategies teachers use to assist students with their problems provide an insight into the cognitive processes teachers may use to begin to identify the student's point-of-view:

Faced with students' responses which deviate in various ways from her own expectations, the teacher who is not aware of the students' "alternative conceptions", and who does not go beyond the students' "incorrect" answers to explore the "why" and "how" (Arlin, 1985) of their responses, will interpret the student's answers as "wrong" (Brooks, 1984). In other words, she does not attend to the student's framework or point-of-view. Rather, she merely provides new

information and examples of the concepts which the students may simply layer onto their alternative conceptions through memorization. In these "well-defined problem situations", students who memorize the teacher's definitions and who receive praise for doing so, are only "masking" their own framework for constructing the concepts. Teachers who use this method tend to identify the nature of the problem the students are having with the curriculum task as known to both herself and to the student (Getzels, 1964; Getzels & Csiksentimihalyi, 1976). These teachers see the solution of the problem as merely requiring the discovery of the answer the teacher originally expected. Correct answers are for the teacher, evidence that she is doing a good job of teaching (Paley, 1986).

By contrast, the teacher who is aware of students' "alternative conceptions" and who values the "child's point-of-view" (Elkind, 1976), allows herself to experience surprise, and recognizes that in these "unexpected" situations, predefined methods or procedures are no longer useful for assisting her students with their problems and questions (Schön, 1983, 1987). She recognizes the discrepancy between her own understanding of the concepts, the understanding she initially expected from her students, and the understandings she actually received from her students upon presentation of the curriculum tasks or materials. From this recognition, she generates alternative explanations about the students' thinking (Schroeder, Driver & Steufert, 1967) and makes informal hypotheses, based on her own repertoire of experiences and actions, about "how" the "incorrect answers" could be the "correct answers" for the students (Arlin, 1983). She then asks the students, through "thoughtful questions" (Brooks, 1984) based on these hypotheses, "how" they got their answers. Here, the teacher sees the nature of the students' problems as

unknown to both herself and to the students. She sees the solution to this "discovered" or "ill-defined problem" as a situation requiring further discovery and elaboration (Getzels, 1964; Getzels & Csiksentimihalyi, 1976).

In the present study, students' responses to what teachers believe to be "well-defined" curriculum tasks have been redefined to represent "ill-defined problem situations" for the teacher. Ill-defined problems are, in fact, the basis for problem finding (Arlin, 1975-76). The concept of problem finding can contribute to the understanding of classroom problems as ill-defined problems by providing a framework which informs the teacher's own construction of knowledge. How, then, do teachers identify classroom problems as ill-defined problems?

3. Studies of Problem Finding

The need for studies of problem finding in educational settings (Dillon, 1982; Getzels, 1964; Getzels & Dillon, 1973; Mackworth, 1965) and in studies of adults in general (Arlin, 1984, 1986; Sinnott, 1981, 1983) has been suggested. Few such studies exist (Arlin, 1975-76, 1977, 1986; Dillon, 1982; Getzels & Csiksentimihalyi, 1976; Yinger, 1980).

Getzels (1964) stated that, "it is the processes involved in [problem formulation] that we [researchers] know least about from the point of view of either learning or teaching" (p. 247). In view of his observation, Getzels (1964) proposed a three step model of problem solving: the formulation of the problem, the development of a method of solution and the acquisition of a solution. He made the differentiation within this model between "presented" and "discovered" problems in terms of

"what is known and what is unknown [by the presenter and the solver] in the problem-situation" (Getzels, 1964, p. 241). He described as routine, the mental operations involving known or already formulated problems, methods and solutions. By contrast, he described the operations involving unknown problems, methods and solutions as creative mental processes. Between the "presented" and "discovered" problem types he proposed a continuum of eight problem types which require varying degrees of "innovation" and "creativity" for solution. The first type of problem typifies the situation where an individual, given a problem, is merely required to "plug the given data into the given formula or to use the known method to find the answer" (Getzels, 1964, p. 242). The remainder of the problem types require "creative thinking", where the "principle of solutions, and perhaps even the essential question itself, must be discovered" (Getzels, 1964, p. 242). For Getzels, the highest form of discovery requires problem finding. However, problem finding may be more a matter of reflection than of creativity.

Mackworth (1965), at about the same time as Getzels, proposed a qualitative difference between problem solving and problem finding within an information processing framework. He defined problem solving as "the selection and use of an existing program from an existing set of programs" (p. 57). By contrast, he defined problem finding as "the detection of the need for the new program by comparing existing and expected future programs" (p. 57). Methods also differed. The method of problem solving was "experiment" while the method of problem finding was "thought". The successful outcome of problem solving was "the discovery of one specific acceptable answer to one well-defined problem" (p. 57). The successful outcome of problem finding was "the discovery of many general questions from

many ill-defined problems" (p. 57).

Yinger (1980) adapted these models of problem finding to studies of teacher planning (Clark & Yinger, 1977; Yinger, 1980) in order to examine the cognitive planning processes of teachers in laboratory school settings. He saw problem finding as the first step in the teacher's planning process where the outcome was an initial problem-conception, and the overall purpose of the problem-finding process was to generate ideas. In terms of teacher planning, Yinger (1980) defined problem finding as "the discovery of a potential instructional idea that requires further planning and elaboration" (p. 84). In this model, the problem finding process represented an interaction among four components: (1) the planning dilemma confronting the teacher -- the process by which the teacher becomes aware of a problem that needs to be solved, (2) the teacher's knowledge and experience -- the ways in which the teacher has learned to perceive the problem situation, and the knowledge and methods the teacher can draw from her memory, (3) the teacher's conceptions of teaching goals which include her implicit and explicit notions of effective teaching for specific groups of students, and (4) the teaching materials which include concrete materials and any source of information that is and can be used in the classroom. For Yinger (1980), problem finding occurs in planning prior to the interactions with students and not necessarily in the act of instruction.

What is problematic with these conceptions of problem finding is that while they attempt to apply notions of problem finding to studies of teachers and their teaching, they neglect to indicate "how" this ability is acquired and "how" the teacher comes to identify classroom problems as ill-defined problems. Although these

researchers describe what may be the basic processes of problem finding, they neglect to discuss the mechanisms of development through which these processes and skills of problem finding are acquired. And, they ignore the implications that the Deweyian-Piagetian traditions have for educational practice. What is needed within a problem finding framework is a description of the type of reflection-in-action conceived of in this study as the basis for teaching from the student's point-of-view. A description of the teacher as problem finder may provide an insight into the question, "How do teachers identify the child's or adolescent's point-of-view when faced with classroom problems which may be defined as ill-defined problems?"

C. THE TEACHER AS PROBLEM FINDER

1. The Teacher's Own Construction of Knowledge

Arlin (1975-76), building on the work of Getzels and Csiksentimihalyi (1976) and Mackworth (1965), proposed a cognitive developmental model of problem finding. Several cognitive process variables were identified as potential predictors of problem finding ability. These included: selected variables drawn from Guilford's "structure of the intellect model" (1956), Schroeder, Driver and Steufert's (1967) levels of information processing, and Inhelder and Piaget's (1958) formal operational schemes. In this cognitive process model, it was proposed that when subjects are presented with "problem-rich" objects, they are provided with an opportunity to ask questions in the face of "stimuli" or what Mackworth (1965) referred to as "ill-defined problem situations". For Arlin (1975-76, 1977, 1986), these "ill-defined" problem situations initiated the processes of problem finding, where a subject's failure to

employ a mainline process, such as the integration of information (Schroeder, Driver & Steufert, 1967), resulted in the production of a lower level question, which was designated as "output". By contrast, subjects who gave evidence of employing the mainline processes of discrimination, differentiation and a high level of integration (Schroeder et al., 1967) tended to generate many 'general questions' from many ill-defined problems (Arlin, 1975-76; Mackworth, 1965). For Arlin, the 'general question' represented the outcome of problem finding. She described this process as, "the various organizations of information that could be inferred from the types of questions posed and the types of cognitive operations which correlate with these outputs." Findings (Arlin, 1975-76, 1977, 1986) supported the hypothesized relationship between problem finding and the proposed set of cognitive process variables.

2. The Teacher's Own Reflection-in-action

Recently, Schön (1983, 1987) proposed that "the practitioner has built up a repertoire of examples, images, understandings and actions..." (1983, p. 138) which includes the whole of her experience insofar as it is accessible to her for understanding and action. For the teacher, these "examples, images, understandings and actions" as well as previous solutions to instructional problems (Brooks & Fusco, 1983; Yinger, 1980) become the "ground" for analyzing the new interactions. It is interesting that Schon chooses to call these previous experiences and actions the "practitioner's repertoire". Piaget (1979) also chose the term "repertoire" to describe the child's "reflexive abstraction" and the adolescent's "reflective abstraction" which leads to concept development (Arlin & Levitt, 1986; Gallagher & Reid, 1981).

Like the child or adolescent, the teacher (adult) is engaged in a similar type of repertoire building. It is through the process of "reflection-in-action" that the teacher's "knowing-in-action" is constructed. As she "knows-in-action" (Schön, 1983, 1987), she too builds up a repertoire of experiences and actions in the practice situation. If the teacher reflects upon these experiences and actions, she will construct her own concepts of teaching, learning, instruction, and education. "Reflection-in-action" hints at the nature of the cognitive processes that the teacher may use to construct new knowledge when faced with student's "unexpected" responses to curriculum tasks in the practical context. Schön's description of "reflection-in-action" may go beyond Piaget's conception of development to include the structures which inform the adult's experiences and actions.

No present teaching situation is exactly like a previous one and yet there are features that they share in common. It is in these "unique" situations that the teacher, through reflection-in-action, extracts these common features and maps them on to the new situation, making moment-to-moment subtle adjustments to that which is new. This is illustrated through Schön's (1983, 1987) definition of "reflection-in-action":

> There is some puzzling, or troubling, or interesting phenomena with which the individual is trying to deal. As he tries to make sense of it, he also reflects on the understandings which have been implicit in his action, understandings which he surfaces, criticizes, restructures, and employs in further action. (Schön, 1983, p. 130)

Schön (1983, 1987) refers to the practitioner's way of understanding a unique situation as one of "problem setting". When a practitioner sets a problem, she chooses and names the things she will notice. Then, through complementary acts of

naming and framing, she selects things for attention, and organizes them. Schön states that individuals frame problematic situations in different ways depending on their backgrounds. Furthermore, because a unique case falls outside the categories of a teacher's available theories and techniques, she is unable to treat the situation as an instrumental problem, that is, one to be solved by the application of the rules in her store of professional knowledge. In other words, the specific situation she is confronted with is not "in the book" (Schön, 1987). In problem finding terms, the situation is "ill-defined".

In order to deal competently with the unique situation, the teacher must do so by a kind of "improvisation, inventing, testing in the situations, strategies of her own devising" (Schön, 1987, p. 5). Specifically, the teacher follows a process where, (a) she experiences a surprise that leads her to rethink her knowing-in-action in ways that go beyond available rules, facts, theories and operations, (b) she then responds to the unexpected situation by restructuring some of her strategies of action, theories of phenomena, or ways of framing the problem, and finally, (c) invents on-the-spot experiments to put her new understandings to the test (Schön, 1987, p. 35). A transformation of thought takes place with each new situation where an integration between prior understanding and present phenomena takes place. The teacher makes something. Her reflection-in-action is a "reflective conversation with a unique and uncertain situation" (Schön, 1983, p. 130), a "conversation" in a metaphorical sense (Schön, 1983). It is interesting that Schön describes his concept of "reflective conversations as "[spiraling] through stages of appreciation, action and reappreciation" (Schön, 1983, p. 132). Piaget also described the function of his levels of cognitive development as a "continuous process of cognitive structurations".

However, Schön's description allows the teacher to go beyond thinking about her own thinking (Lampert, 1984; Piaget, 1978) and thinking about doing something (Yinger, 1980) to thinking about doing something while doing it (Schön, 1983). Within a problem finding framework the teacher constructs her own situation of practice before attempting to solve it. Through this process, Schon sees the practitioner acting more like a research scientist "trying to model an expert system than like the 'expert' whose behavior is modeled" (1987, p. 35-36). In this view, the teacher is able to integrate reflection-in-action into the smooth performance of on-going instruction (Schön, 1987).

What Schön's work suggests for the present study, is that if the teacher's "knowledge-in-action" (her own theories about childrens' knowing-in-action), is informed by a "developmental perspective" (Arlin, 1983; Brooks, Fusco and Grennon, 1983; Elkind, 1976; Feldman, 1981), which in turn, informs the teacher's "reflection-in-action" (Schön, 1983, 1987), then the teacher may come to know the logic or framework that a child or adolescent brings to a particular curriculum task. The information the teacher gains about the student's framework will be about the student's operations themselves. Schön's description of "how" professionals translate theory into practice may describe "how" teachers construct their own knowledge about the child's or adolescent's point-of-view in the practice setting. In addition, a problem finding framework which informs the teacher's reflection-in-action and which describes the steps a teacher goes through in making sense out of the ill-defined situation may describe the "teacher as problem finder", that is, the extent to which the teacher is able to identify classroom problems as ill-defined problems and thus begin to identify the student's point-of-view.

D. SUMMARY

The nature of the present study is to explore the ways in which teachers identify the child's or adolescent's point-of-view when faced with classroom problems which may be described as ill-defined problems. In addition, it will explore the extent to which the "teacher as problem finder" describes those teachers who have the structures and strategies available to them for discovering the student's point-of-view in the instructional context. The major purpose of the study is to generate hypotheses about these research questions. The emphasis is on the description of phenomena and on the development of hypotheses from a data base as opposed to the formal setting, testing and confirmation of hypotheses. This is supported by research which suggests that research on teaching should be based on the selection of natural versus experimental methods for classroom study (Shulman, 1965).

By asking the teacher what kind of problem she thinks a student is having with a curriculum task presented in the simulation, the researcher has the opportunity to reveal the teacher's framework or point-of-view for understanding "how" the child or adolescent "has a concept" (Larsen, 1977; Strauss, 1981). It is then possible to explore the teacher's methods of interpreting the student's "wrong" answers and to use this information as a guide to understanding the teacher's thinking (Arlin, 1983; Sinclair & Kamii, 1970). The teacher is asked to formulate questions, predict students' responses and suggest strategies for assisting the students with their "problems". These questions reveal the teachers' own thoughts about their teaching and about student thinking (Arlin, 1986b). In short, the teacher is asked to give a description of the steps she goes through to arrive at particular problem formulations and solutions while attempting to identify and interpret classroom

problems from the child's or adolescent's point-of-view. These procedures may be described as the set of questions which inform the present research.

In order to explore how teachers identify the student's point-of-view when faced with classroom problems which are ill-defined problems, operational definitions will be provided for the terms associated with each of the four questions posed. Chapter 3 will describe these procedures and methods.

CHAPTER III. METHODOLOGY

In order to describe how teachers identify the child's or adolescent's point-of-view when faced with ill-defined problem situations, teachers' responses to the following set of four questions which accompany a selection of classroom scenarios, will be explored (see Appendix A):

1. What kinds of problems do you think these students are having with the assignment? Why do you think so?

2. What questions do you think these students were asking themselves as they worked through the assignment? Why do you think so?

3. What questions would you, as their teacher, ask these students about the problems that you think they are having with the assignment? What responses would you expect to get? Why do you think so?

4. How would you proceed to help these students with the problems they are having? What strategies would you use? Why?

In addition, the teacher's concern for problem finding and several demographic variables of interest to the present study will be considered.

Chapter 3 provides a description of the sample and a discussion of the methods and procedures as they relate to the research questions.

A. DESCRIPTION OF THE SAMPLE

The present study consisted of a total of 27 experienced teachers, participating in district-sponsored in-service courses in a suburban/urban coastal area of Maine and in a suburban area on Long Island, New York. The in-service courses were designed to introduce participants to a developmental perspective (Arlin, 1983; Elkind, 1976; Feldman, 1981), and to strategies for "teaching for thinking" (Arlin, 1985) from "the

child's point-of-view" (Elkind, 1976). Participants represented two grade level categories based on demographic information collected at the beginning of the in-service course (see Appendix B, Questions 2-7): 15 participants represented the Primary Grades (K-3) and 12 participants represented the Intermediate Grades (4-8). This method of grouping takes into account the effects of familiarity and experience on the quality of teachers' responses (see section on 'Task Administration') and provides additional demographic information which may be of interest to the present study (see Appendix B).

B. PILOT STUDY

An initial set of 12 anecdotes was administered to 26 consenting in-service and pre-service teachers in order to validate the clarity of the tasks and to examine the relevance of the subject and grade levels associated with each task. Based on an examination of the responses given on these initial tasks, modifications were made to the final set of 8 tasks chosen for use in the present study (see Appendix A). The four tasks eliminated from the final set were those which were not based on a teacher's own telling of a classroom problem and/or which tended to pose interpretation problems for the teachers.

C. PROCEDURES

'The Student Anecdotes Task' (Levitt & Arlin, 1986) was used to explore "how" teachers identify the child's or adolescent's point-of-view when faced with classroom problems which may be described as ill-defined problems (see Appendix A). The description of the task is divided into four sections: (1) Task Rationale, (2) Task Development and Description, (3) Task Administration, and (4) Rating Criteria and

Examples of Teachers' Responses. Section (5) will include a discussion of other variables of interest to the present study (see Appendix B). These include, (a) the teacher's concern for problem finding (see Appendix B, Question #1), and (b) a variety of demographic variables (see Appendix B, Questions #2-7).

1. Task Rationale

The rationale for the development of 'The Student Anecdotes Task' (Levitt & Arlin, 1986) was based on the premise that students' routine responses to curriculum tasks and materials presented to them by their teachers during classroom instruction often deviate from the teacher's original expectations. There is a need to identify "how" teachers construct their own knowledge (reflect-in-action) as they deal with "unexpected" problems from the student's point-of-view. It was therefore proposed that, in order to identify the ways in which teachers think about and interpret the problems and questions students have with curriculum tasks in the classroom researchers need to ask questions which elicit the teachers' responses about these situations and to explore the "why" and the "how" of the teacher's responses from the teacher's own point-of-view. In the present study, clinical interview questions based on a constructivist view of educational practice were used to elicit responses from teachers in order to provide a way of exploring the processes and structures they might have available to them for identifying how a child "has a concept" within the context of the classroom. The 'Student Anecdotes Task' provides this method of exploration.

2. Task Development and Description

a. *Task Development*

A variety of instructional worksheets and classroom discussion scenarios from different grades and subject areas were used to construct "real-life" student anecdotes to serve as the stimuli or "ill-defined" problems for initiating processes of discovery in teachers. (see Figure 2 for Sample Scenario) Each scenario was taken from a teacher's own telling about an activity in her own classroom (see Appendix A). Therefore, the scenarios represent simulations of problematic situations that teachers might normally encounter in their classrooms. This method of task development is supported by findings in the literature that, "[i]n general, ...stimulus situations implying conflict, uncertainty, and control in a given domain, produce more construct relevant responses" (Schroeder, Driver & Steufert, 1967, p. 186). In the present study, this "conflict, uncertainty, and control" is represented by students' verbal or written responses to curriculum tasks which reflect their points-of-view, and which deviate from the teacher's own expectations of student task performance.

In order to record teachers' interpretations of the students' points-of-view, each of the tasks is accompanied by a standardized answer sheet containing specific instructions and four questions pertaining to the scenario. The questions were designed to reflect the Piagetian clinical method of stimulating thinking about an abstract stimulus and were developed from literature based on a constructivist view of "teaching for thinking" (Arlin, 1985) from a "developmental perspective" (Elkind, 1976; Feldman, 1981). The major function of these questions was to conduct a "conversation" with participants in the study to find out "how" they "have the

concept" of the child's point-of-view.

The clinical interview questions which accompany each of the scenarios give participants an opportunity to respond to a discrepant or "ill-defined" problem situation (Arlin, 1975-76, 1986; Mackworth, 1965). This method of eliciting responses is supported by findings that the most valid accounts of teachers' thinking are found in "natural inquiry situations" (Shulman, 1965), and that there is a need to "permit teachers to express themselves in their own terms about all aspects of the teaching learning process" (Hunt, 1980, p. 66). The form of the questions is also influenced by the literature on problem finding as the questionnaire is designed to elicit the teacher's own questions and problem formulations.

b. Task Description

A total of 8 student anecdotes make up 'The Student Anecdotes Task'. Each anecdote is classified into one of two main categories representing the grade level of the student(s) who completed or responded to the particular curriculum task or material:

Category I: Primary (Grades K-3)

Category II: Intermediate (Grades 4-8)

The tasks are further classified into the following two Subject Categories: (1) Physical Sciences/Mathematics (Science; Math), and (2) Humanities/Social Studies (English/Reading; Social Studies). This method of organization provided a framework from which participants were asked to select one task for completion based on their background and experience (see section on 'Task Administration').

Figure 2: Sample Scenario

PRIMARY (Grades K-3) - MATH
(C. Reynolds, personal communication, October 1984)

The following worksheet on finding the standard number was completed by a grade 3 student at the beginning of the school year and was marked by the teacher. Please examine the worksheet carefully and answer the questions on the following page.

6X

Directions: Write the standard number.

1) 3000 + 200 + 20 + 6 = 3226
2) 6000 + 500 + 2 = 652X
3) 2000 + 0 + 0 + 9 = 2009
4) 800 + 30 + 7 = 837
5) 7000 + 900 + 90 + 1 = 7991
6) 1000 + 200 + 80 + 0 = 1280
7) 3000 + 200 + 10 + 7 = 3217
8) 9000 + 100 + 8 = 918X
9) 1000 + 700 + 60 = 176X
10) 3000 + 300 + 70 + 8 = 3378
11) 200 + 10 + 7 = 217
12) 8000 + 3 = 83X

13) 4000 + 100 + 30 + 7 = 4137
14) 1000 + 600 + 8 = 168X
15) 700 + 50 + 6 = 756
16) 4000 + 60 + 3 = 463X
17) 7000 + 700 + 50 + 6 = 7756
18) 200 + 90 + 5 = 295
19) 700 + 20 + 5 = 725
20) 5000 + 400 + 50 + 8 = 5458
21) 2000 + 600 + 10 + 9 = 2619
22) 8000 + 300 + 60 + 2 = 8362
23) 500 + 30 + 1 = 531
24) 800 + 70 + 7 = 877
25) 800 + 60 + 6 = 866

(Sample Scenario cont...2)

Name: _____

ANSWER SHEET - (PRIMARY/Math)

Imagining that you are the teacher in this situation, please answer the following questions as thoroughly as you can: (Feel free to use the back of the page if necessary)

1. What kind(s) of problem(s) do you think this grade 3 student is having with this assignment? Why do you think so?

2. What question(s) do you think this student was asking him/herself while working through the assignment? Why do you think so?

3. What question(s) would you, as the teacher, ask this student about the problem(s) that you think he/she is having with the assignment? What responses would you expect to get? Why do you think so?

4. How would you proceed to help this student with the problem(s) he/she is having? What strategies would you use? Why?

3. Task Administration

At the beginning of their in-service course, consenting participants were asked to complete 'The Student Anecdotes Task' (Levitt & Arlin, 1986). Two grade levels were represented: 15 participants represented the Primary Grades (K-3) and 12 participants represented the Intermediate Grades (4-8).

Participants were instructed to select one task and its corresponding response sheet from the Subject Category and Grade Level group which best represented the general age group and subject area that he/she most often taught, or was most familiar and comfortable with. This selection procedure was based on findings that adults tend to perform better when their experience is taken into account (Piaget, 1972; Sinnott, 1975; Sinnott & Guttman, 1978), and on suggestions that adults should be tested using materials most familiar to them (Piaget, 1972; Sinnott, 1975). In this view, it is assumed that familiarity with age/grade of the student(s) and the subject matter represented in the chosen task would provide the most appropriate context for the teachers to reveal the experiences, knowledge and cognitive processes that are most often activated and used when they are faced with ill-defined problem situations.

Participants were given the option of completing their anecdotes during the time provided at the beginning of the course or in a place of their own choosing over a period of two weeks, at which time they were collected by course leaders and returned to the investigator. In addition, participants were asked to complete a questionnaire requesting their responses to several variables which may be of interest to the present study (see Appendix B).

4. Rating Criteria and Examples of Teacher's Responses

The standardized answer sheets which accompany each classroom scenario contain specific directions to four questions developed from the literature review to probe the teacher's thinking (see Sample Scenario, Figure #2). Each of the four questions was rated according to the criteria specified in the following discussion. Each contains examples of teachers' responses as they relate to the rating criteria. The four sections include: (1) problem formulation, (2) integrative complexity, (3) quality of point-of-view, and (4) developmental teaching strategies. In addition, the teacher's "concern for problem finding in the general context of her work" (Getzels & Csiksentimihalyi, 1976) and a variety of demographic variables of interest to the present study are also presented.

#1. Problem Formulation: What kind(s) of problem(s) do you think this student is having with this curriculum task? Why do you think so?

Teachers' responses to this question were scored according to the eight types of problems and processes of solution identified by Getzels (1964). These represent a continuum from "presented" problems to "discovered" problems in terms of what is known and what is unknown by the presenter/teacher and the solver/student in the problem situation (Arlin, 1986a, in press; Getzels, 1964; Getzels & Csiksentimihalyi, 1976; Getzels & Dillon, 1973). Modifications of these categories of problem formulation have been derived to reflect the nature of the task (see Table 1):

Table 1: Problem Formulation - Scoring Categories and Examples

Type 1:	The teacher interprets the student's problem as known and thinks that there is a standard method for solving it available to the student and to herself and therefore guarantees a solution in an identifiable number of steps. Example: "They are having trouble with place value (10's)".
Type 2:	The teacher interprets the student's problem as known but indicates that no standard method for solving it is known to the student, although it is known to herself. Example: "The student is having problems with the concept of place value and expanded notation. The child is not ready to abstractly apply the concept of place value".
Type 3:	The teacher interprets the student's problem as known, however indicates that no standard method for solving it is known by the student or herself. Example: "The students seem to be having a problem with the definition of fraction. In some cases, it looks as if they don't understand that a fraction can be more than just 1/2 etc. Perhaps the teacher's methods (examples) were not clear."
Type 4:	The teacher states that the student's problem exists but indicates that it remains to be identified or discovered by the student, although she herself knows the nature of the problem. Example: "Students don't know what to do with unlike denominators -- they have never been exposed to this before, [therefore] novel -- Problem establishing a relationship between (1/2 + 1/4) = (4/8 + 2/8) = because it's too abstract -- haven't dealt with it at the concrete level..too complex."
Type 5:	The teacher states that the student's problem exists but indicates that it remains to be identified or discovered by the student and by herself. Example: "It doesn't seem that the students have grasped the concept of fractions with similar denominators because none of the students got the correct answer. The problem is probably that the students don't know how to find a common denominator (or maybe they don't know what a common denominator is!) Another problem might be with fraction addition itself."

Type 6:	The teacher states that the student's problem exists but indicates that it remains to be identified or discovered and that there is a standard method for solving the problem known to the student and to herself, once the problem is discovered. Example: "The children appear to be having a problem transferring what they already know about numerals and their values to the new knowledge about how values change according to the place of the numeral...I feel that at this point the students have not received enough practice in finding groups of tens in a set and then labelling the set according to the ____tens and ____ones."
Type 7:	The teacher states that the student's problem exists but indicates that it remains to be identified or discovered, and that no standard method for solving it is known to the student although known to herself. Example: "These children (most of them) would be in the concrete operational stage. These children would have difficulties relating the concrete with the abstract. If the teacher showed them addition with pie fragments these kids would have no problem answering the questions. However, when doing problems from the textbook the kids might have difficulty".
Type 8:	The teacher states that the student's problem exists but indicates that no standard method for solving it is known to the student or to herself. Example: "The questioner is asking her [Roberta] to give information she cannot answer from the paragraph. He/she is asking Roberta questions that require prior knowledge inappropriate for a 7 year old to be expected to have."

Type 1 problems represent "presented" or "well-defined" problems which reflect the teacher's view that students "need only to plug the given data into the given formula or the known method to find the [correct] answer" (Getzels, 1964, p. 242) to a curriculum task. This teacher may suggest that the students be presented with new information in an attempt to obtain the desired results. In problem types 2 through 8, "the principles of solution, and perhaps even the essential question itself, must be discovered" (Getzels, 1964, p. 242). The highest form of discovery (Problem Type 8) requires problem finding (Getzels, 1964). In view of findings that

problem finding functions effectively within discovered or ill-defined problem situations (Arlin, 1975-76, 1977, 1986; Getzels & Csiksentimihalyi, 1976); teachers who view classroom problems as ill-defined problems may have the structures and strategies necessary for identifying classroom problems as ill-defined problems. They may be problem finders in their own classrooms.

#2. Integrative Complexity: What question(s) do you think this student was asking him/herself while working through the task? Why do you think so?

The teacher's response to this question reflects the extent to which she attempts to formulate alternative explanations about the questions students ask themselves as they work through instructional tasks. In situations where the student's response deviates from the teacher's expectations of teaching and learning, the teacher must recognize the discrepancy between the processes she would use to respond to the task, the methods she expects the students to undertake, and the methods the students actually take to respond to the task. In these ill-defined problem situations, the teacher who has the potential for identifying the student's point-of-view will generate alternative explanations for these differences by asking herself the question: For what question is this student's wrong answer, in fact, the right answer for the student? (Arlin, 1983; Sinclair & Kamii, 1970). In this view, the level of conceptual structure the teacher uses to generate her response is related to the extent to which she produces alternate interpretations (organizations) of the situation.

Criteria Used to Rate Integrative Complexity:

Four categories represent a set of general operations for inferring the level of conceptual structure used by the teacher to generate her response to question #3:

1. The Low Integration Index consists of "a hierarchical set of established rules and procedures" (Schroeder, Driver & Steufert, 1967, p. 23).
2. The Moderately Low Integration Index is characterized by a movement away from absolutism accompanied by a lack of consistency and rigidity.
3. The Moderately High Integration Index is characterized by the provision of more complex rules for comparing and relating (i.e., a person can observe the effects of his own behavior from several points-of-view).
4. The High Integration Index gives the person the potential to generate alternate patterns of complex interactions (Schroeder et al., 1967, p. 23).

Responses are scored along a 4-point scale which represent a continuum from low to high levels of integrative complexity. Each major point (low, moderately low, moderately high, high levels of integrative complexity) represents a modal level of conceptual structure. In order to make adequate inferences about the integrative complexity of the teacher's responses, the raters have been directed to ask themselves:

> Can it be inferred that the teacher's response was generated by a conceptual structure which failed to produce alternative interpretations (organizations) of the event?

The following descriptions of the levels of integration have been modified to reflect the nature of the task (adapted from Schroeder et al., 1967, p. 187-189):

Table 2: Criteria for Rating Integrative Complexity

Scale Value 1: Low Integration Index

- The teacher views the student's response as unpleasant or as a flaw or weakness in the student.
- The teacher seeks fast and unambiguous closure or resolution to the student's problem and reacts in such a way as to engage internally consistent processes that reduce incongruity or dissonance.
- The teacher offers the student a specific guide or rule to correct the problem and thus reduce conflict.
- The teacher implies that an absolute solution can be found to the student's problem.
- The teacher states that effects are compartmentalized, are all one way or all another way.
- The teacher presents only one side of the problem (her own side) while ignoring differences and similarities with the student's views.

Example: "Why isn't it worth '1'? Why isn't it correct the one is on the left, I circled the 1st one on the left."

Scale Value 2: Medium Low Integration Index

- The teacher lists similarities and differences between her own views and those of the student without considering relationships.
- The teacher specifies at least two different hypotheses about the nature of the student's problem(s).
- The teacher uses "either-or" types of responses expressing a possible conditional rule about two ways of categorizing.
- The teacher makes probability statements about the occurrence of the student's problems.
- The teacher reacts against absolutism in general (the possession of more than one view without the rejection of a particular view).
- The teacher avoids dependency on external imposition; that is, the availability of alternatives (this does not include opposition to a particular categorization).

Example: "Where is or are continents/oceans relative to ME/USA/N America? A person works from homebase outward or familiar to unknown."

Scale Value 3: Medium High Integration Index

- The teacher integrates the student's and her own conflicting interpretations of the instructional task so as to preserve and not "ward off" the conflict.
- The teacher generates various meanings of alternate perceptions, such as various meanings of the perception of conflicting views about how the student

has the concept.

- o The teacher's response provides evidence that the completion implies the ability to take the student's perspective or point-of-view into account and to relate different perceptions of different people.
- o The teacher's response implies that one's behavior is affected by the way another behaves, as in a give-and-take strategy game
- o The teacher views social relationships as anchored in mutual responsibility (as opposed to fixed beliefs or rules), in which each person can "place himself in the other person's shoes" (relate alternate schema).

Example: "Possibly repeating the teacher's question and trying hard to remember the exact words stated by the teacher in her presentation. With no concrete examples, memorization is all the students had to use."

Scale Value 4: High Integration Index

- o The teacher's response indicates that conflicting alternatives lead to new organizations and information.
- o The teacher uses alternatives through exploratory action in order to obtain new information from the student.
- o The teacher generates functional relations between alternatives.
- o The teacher considers relationships among similarities and differences between the sides of a problem or question, a development of relationships between alternate reasons as to why these differences and similarities exist.
- o The teacher produces responses reflecting more "connectedness" between alternatives by theorizing as to why these reasons exist.

Example: "I think Roberta is trying very hard to draw on prior knowledge and she is trying to concretize her answers to the questions and draw on her experiences."

#3. Quality of Point-of-View: What question(s) would you, as the teacher, ask the student(s) about the problem(s) you think they are having with the task? What responses would you expect to get? Why to you think so?

The kinds of questions teachers pose in ill-defined problem situations may be understood in terms of the developmental capacities that each teacher brings to those situations (Arlin, 1977):

> Questions which are sensitive to a student's cognitive level are questions which support the student's thinking, which challenge him, and which encourage him to construct his knowledge about the content of the question. (Arlin, 1986b, p. 17)

The quality of the questions teachers use to elicit information about the problems their students are having with instructional tasks may describe the extent to which they discover the child's or adolescent's point-of-view (Arlin, 1977).

Criteria Used to Rate "Quality of Point-of-View":

Rating categories for question #3 are based on a modification of Guilford's (1956) six intellectual products categories. These are used to identify the 'general questions' (Mackworth, 1965) posed as distinguished from all other questions posed:

Category 1: units	Category 4: systems
Category 2: classes	Category 5: transformations
Category 3: relations	Category 6: implications

Within a problem finding framework (Arlin, 1975-76, 1977, 1986), each of the six categories represent the way in which information is structured by the teacher. Category definitions in Table 3 are modified to reflect the nature of this study (in Arlin, 1975-76).

Table 3: Rating Criteria for 'Quality of Point-of-view'

Category	Definition
	The teacher:
1. units	attributes the student's problem to lack of basic information; gives reasons why the student doesn't know something Example: "What does the 1 stand for in 16? '10'."
2. classes	attributes the student's problem to different classes of learning problems; gives slow-learning problems as the reason why the student doesn't know something

Example: "...Is this a city or a country? Is it near Alabama or far away? Can a city be inside a state?...She doesn't have enough information or experiences to understand."

3. relations — attributes the student's problems to observable connections between ways in which the student knows the information
Example: "How can she understand what belongs together and why?"

4. systems — attributes the students' problems to different ways in which information is organized within a system; conducts a task analysis
Example: "I wouldn't have asked her any of those questions past the 3rd one. I would have proceeded differently. I would have asked: Is Alabama in the United States? What is the United States? How is Wisconsin like Alabama? How is the place Caddie lives like the place you live? How is it different?...I would never have introduced "country" and "town" in my questions. I think it confused her. I would have asked further questions about how countries are alike and different. Once introduced, I might have asked her what the differences between a town and country were".

5. transformations — attributes the student's problem to changes in the way the student knows the information; identifies the student's point-of-view
Example: "It depends greatly upon what has been previously introduced to the children. If this is a new topic of study I don't believe I would ask many questions except maybe to spark interest in the upcoming subject of place value. I might ask, "Why didn't you circle all of the wheels?", "If there are 16 wheels and I ask you to circle both numerals in this number, why haven't all of them been circled?" I would expect them to explain to me what they know about the values of 1 and 6. Then this could lead to a discussion of 1 standing for 1 group instead of 1 object."

6. implications — questions the nature of the child's problem and predicts the student's point-of-view based on a developmental analysis
Example: "First I would ask why they think the answer they gave is correct. From their frame of reference, I'm sure their answer makes sense to them; their answer merely mirrors their reality of the matter."

Each category represents the form that information takes once it is processed, that is, the way in which the information a person takes from the stimulus is organized and processed and finally produced in the form of a question (Arlin, 1986a; Guilford, 1956). In the case of question #3, the categories are used to elicit two types of information: (1) to represent the ways in which teachers organize information (Arlin, 1977, p. 298) when faced with classroom problems which are ill-defined problems, and (2) to indicate the degree of abstraction present in the teachers' questions (Arlin, 1977). Regarding the organization of information, units questions represent a low level of organization requiring only the recognition of attributes of the students. By contrast, implications questions reflect a high level of organization and the teacher's ability to organize the ill-defined problem situation in such a way that a "general quality is abstracted that is not readily apparent in the stimuli" (Arlin, 1977, p. 298). Information reflecting the degree of abstraction in the response indicates that teachers who ask units questions tend to use concrete information while those who ask implications questions reflect a higher level of abstraction (Arlin, 1977).

Calculation of Question Quality:

Question quality represents a weighted average of the number of questions by category (Arlin, 1975-76, 1977):

$$\text{Quality} = \frac{1(\text{cat}) + 2(\text{cat } 2) + 3(\text{cat } 3) + 4(\text{cat } 4) + 5(\text{cat } 5) + 6(\text{cat } 6)}{\text{total number of questions asked by the teacher}}$$

A higher order category (transformations (5) or implications (6)) is defined to approach the "general question" (Mackworth, 1965) more closely than a lower order question (Arlin, 1975-76, 1977) and hence, to indicate a high level of problem finding. In the present study, an outcome of transformations or implications represents the teacher's ability to identify the student's point-of-view in the face of ill-defined problems.

#4. Developmental Teaching Strategies: How would you proceed to help this student with the problem(s) he/she is having? What strategies would you use? Why?

Researchers have suggested that the extent to which the teacher is able to elicit ongoing response from the student by asking "thoughtful questions" (Brooks, 1984) may be related to the kinds of strategies the teacher suggests as a next step in the instructional process. In the present study, the strategies that the teachers suggest as a next step in assisting students with the problems she identified them having in the first place, may represent a developmental analysis of the student's point-of-view. The teacher's thematic discussion of strategies which reflect a developmental analysis of the student's point-of-view may indicate that the teacher acknowledges the need to continue in the problem finding process of hypothesis generating and framing until no further response is given (Arlin, 1985; Brooks, 1984).

Criteria Used to Rate "Developmental Teaching Strategies"

The rater's task was to establish the number of different strategies which could be defined as developmental teaching strategies that emerged in each teacher's discussion of procedures. These strategies, delineated from research focusing on a "developmental perspective" (Arlin, 1985, 1986b; Elkind, 1976), provide teachers with the techniques necessary for exploring and revealing their students' own views of

reality. These teachers tend to "consider curriculum and instruction in general, and the minute-by-minute interactions with children in particular from the 'child's point-of-view'" (Arlin, 1983, p. 103). The use of the following strategies provides the next step in the instructional process once the student's point-of-view is discovered:

Table 4: Developmental Teaching Strategies

1. *Hypothesis Generation* (Karmiloff-Smith & Inhelder, 1974, Lampert, 1984; Schön, 1983, 1987). The teacher formulates "on-the-spot" hypotheses about where the learner is in the learning process in order to find a starting point for educational intervention.
2. *Framing/Frameworks* (Arlin, 1986b; Erickson, 1987; Lampert, 1984; Strauss, 1981). The teacher asks students to write down or share in discussion "What they know about...?" or "What is ...?" (Arlin, 1986, p. 19) at the beginning of or during a lesson.
3. *The 'concreteness' principle* (Arlin, 1985). The teacher uses a concrete, physical object or experience (a) to show the students what a concept "looks like" and/or (b) to encourage students to build up a repertoire of connections between concepts and their experience.
4. *Examples continuum* (Arlin, 1986b). The teacher extends the 'concreteness principle' to include the careful selection of different examples to encourage concept development and to promote student understanding rather than simple rote memorization (Arlin, 1986b, p. 19). She helps students notice what is important in the experience to assist in their repertoire building.

5. Questionnaire: Other Variables of Interest to the Study

At the beginning of the inservice course, participants were presented with a questionnaire which requested background information in areas related to children, teaching and educational practice. (see Appendix B) In order to provide additional insight into the teacher's concern for problem finding, participants were asked the question, "Why do you teach?" (adapted from Getzels & Csiksentimihalyi, 1976). In addition, a variety of demographic variables may provide information of interest to the present study. The information gleaned from the questionnaire represents some of the experience and knowledge that participants may have within their teaching repertoire and which may influence their thinking in present instructional situations.

Chapter 4 will provide an indepth discussion of the results as they relate the research questions and findings.

CHAPTER IV. RESULTS

This chapter will provide an exploratory discussion of participants' responses to each of the four questions posed to them in the 'Student Anecdotes Task' (Levitt & Arlin, 1986). The qualitative analysis will consist of an examination of the raw data obtained from participants for each variable, and a discussion of the frequency tables and anticipated correlations pertaining to overall group responses and group responses by subject category/grade level. In addition, a qualitative analysis of the question, "Why do you teach?" and an examination of a variety of demographic variables may provide additional information of interest to the present study. A comparison between a participant rated high on all variables and a participant rated low on all variables may provide further insight into the similarities and differences with respect to how teachers have the concept of the child's point-of-view. The formulation of questions raised as a result of the discussion will be presented with further elaboration in Chapter 5.

Teachers were presented with several anecdotal tasks and were asked to select one classroom scenario in which students provided "incorrect" responses to a curriculum task based on assumptions of previous teaching and learning or after having received instruction from their teacher. Each of the four questions which accompanied the scenarios was designed to conduct a "conversation" with participants in this study in order to elicit their points-of-view, that is, to elicit from teachers, the experience and actions and the cognitive developmental processes available to them for thinking about teaching and teaching for thinking from a developmental perspective. An examination of their responses may provide an

interesting insight into the research question: When faced with a student's "incorrect" response to what they believe to be a well-defined instructional task, how do teachers identify the child's or adolescent's point-of-view?

Identification of Student Anecdotes and Participants' Ratings

Table 5 provides the ratings allotted to the 27 participants on each of the four questions of the 'Student Anecdotes Task'. Each participant is assigned an identification number from #1 to #27. Participants are grouped according to the subject category/grade level from which their scenarios were selected. The eight classroom scenarios of the 'Student Anecdotes Task' can be found in Appendix A.

Within the present chapter, each example used to describe the results will be labelled as follows: [see Appendix A, Scenario #00; see Table 5, Subject #00] This will provide the reader with a relatively efficient method of locating participant's ratings on all tasks as well as the classroom scenario the participant chose for completion.

Interrater Reliability

A random selection of 10 of the sets of responses were coded by a second rater using the categorical descriptions outline in Chapter 3. The initial percent of agreement between the two raters ranged from 66% to 90% depending on the variable being coded. The number of developmental strategies present in each reponse was more at issue. Both raters agreed on the presence of certain strategies, but one rater identified additional strategies not identified by the first rater. The highest percent of agreement was on integrative complexity and quality of

Table 5: Participant Ratings for Problem Formulation (PF), Integrative Complexity (IC), Quality of Point-of-View (QP) and Developmental Teaching Strategies (DT) by Subject Category/Grade Level

Primary Math/Science (n=7)	PF (1-8)	IC (1-4)	QP (0-6)	DT (1-4)
Subject 1	1	1	1	nil
2	2	1	2.7	3
3	1	1	1	3
4	2	1	2	1,3
5	2	1	1	3
6	6	3	5	1,3
7	1	1	1.4	2,3,4,
Primary Hum/Social (n=8)	**PF**	**IC**	**QP**	**DT**
Subject 8	1	1	0	nil
9	2	1	1.5	1,2,3
10	2	2	2	3
11	1	1	1	3,4
12	2	1	2.5	3
13	8	4	4	1,2,3,4
14	1	1	1	3
15	2	2	1.2	3
Interm. Math/Science (n=9)	**PF**	**IC**	**QP**	**DT**
Subject 16	1	1	1	3
17	1	1	1	3
18	2	1	1	3
19	1	1	1	3
20	1	1	1	3
21	6	3	6	2,3
22	4	2	3.5	3
23	1	1	1	3
24	1	1	1	3
Interm. Hum/Social (n=3)	**PF**	**IC**	**QP**	**DT**
Subject 25	1	1	1	nil
26	2	2	1	1
27	1	1	1	3

point-of-view. Initial disagreements with respect to problem formulation were only one category removed except for the responses of one subject. All of the disagreements were resolved through discussion. Given the types of categories employed and the nature of the responses, the inter-rater reliability was more than acceptable.

A. *QUALITATIVE ANALYSIS*

The results will be presented and discussed in the following four sections:

1. Problem Formulation
2. Integrative Complexity
3. Quality of Point-of-view
4. Developmental Teaching Strategies

In addition, the teacher's concern for problem finding and a variety of demographic variables will be examined as other variables of interest to the present study (see Appendix B).

1. Problem Formulation

The first question posed to teachers was designed to examine how and to what extent the teacher identifies the classroom problem as a well-defined or an ill-defined problem situation: "What kind(s) of problem(s) do you think this student is having with this curriculum task? Why do you think so?" Participants' responses to these questions will be examined in terms of their concordance with modifications of the eight types of problems and processes of solution delineated by Getzels (1964) in his description of problem formulation, that is, the differentiation between presented or well-defined problems and discovered or

ill-defined problems and their corresponding processes of solution.

Responses were rated according to the degree to which the teacher viewed the nature of the student's problem and its solution as known or unknown by the student and herself. Table 6 provides a distribution of the ratings for problem formulation. (see Chapter 3 for a description of the types of problem formulation)

Table 6: Frequency Table for Problem Formulation (PF)

PF Type*	Frequency (n=27)	Percent
8	01	03.7
7	00	00.0
6	02	07.4
5	00	00.0
4	01	03.7
3	00	00.0
2	09	33.3
1	14	51.9

*Highest to Lowest Levels of Problem Formulation

The majority of responses were concentrated at the lowest level of problem formulation (level 1). Of the total number of participants (n=27), 14 or 51.9% identified the student's problem as a type 1 problem. The following is an example of a level 1 response:

> They [students] don't know the function of numerators and denominators. They don't see the necessity for including fractions to be added (or subtracted) in the same class. They also have not demonstrated that they are evaluating their answers for reasonableness by using estimating or ranging (forecasting that the answer is known to fall between two extremes and those extremes only). [see Appendix A, Scenario #6; see Table 5, Subject #19]

Responses rated at level 1 of the problem formulation scale suggest that the teacher views the students' problems as well-defined, that is, the nature of the students' problems are known by the teacher and therefore a ready-made solution is available to the teacher and the students once additional instruction has taken place. According to Getzels (1964), the processes used to solve these types of problems tend to reflect a "minimum of innovation or creativeness". As evident in the above example, teachers who are rated at level 1 of problem formulation tend to intimate that their students "need only plug in" additional information or use the teacher's own method of solving the problem to arrive at the correct answer.

By contrast, problems of types 2 through 8 suggest that the teacher views the nature of the student's problem as ill-defined, or as requiring further discovery and elaboration (Getzels & Csiksentimihalyi, 1976). Types 2 through 8 represent increasing levels of problem finding and subsequent problem solving; the processes required to identify and solve ill-defined problems (Mackworth, 1965). Of levels 2 through 8, the majority of teachers gave level 2 responses. Nine, or 33.3% of the participants indicated that they had identified the problem that the student was having with the task as well as the method required to solve the problem, but suggested that until further instruction took place, the method of solution would remain unknown to the student. The following is an example of a level 2 response:

> From my own experience in 3rd grade I know that spatial concepts are "difficult" at this age (but less so than time, I think). Directionality; size relationships; differences between states, countries and continents can all be beyond even the 3rd grader--I think they're pretty impossible before that. [see Appendix A, Scenario #4; see Table 5, Subject #15]

These responses may reflect the lowest level of creative thought processes used by a teacher to begin to identify a student's problem from the student's own point-of-view.

Teachers in the present study did not provide responses at levels 3 or 5. Only one teacher responded at level 4 of problem formulation:

> They [the students] are dealing with a new situation in the abstract notational form apparently without prior experience in exploring the situation in the concrete situation. [see Appendix A, Scenario #6; see Table 5, Subject #22]

The remaining responses were at levels 6 (2 teachers) and 8 (1 teacher). This indicates that a minority of teachers provided responses which reflect the use of thought processes associated with problem finding at levels high enough to identify the students' problems as ill-defined. The following is an example of a level 6 response:

> The students appear to lack the conceptual understanding of material presented. Answers given are partially correct but after only a brief lesson with perhaps no concrete examples demonstrated, the students really lack the experience to grasp this topic. [see Appendix A, Scenario #7; see Table 5, Subject #21]

From this response it can be inferred that the teacher is aware that the students are having a problem understanding certain concepts, but that the actual nature of the students' problems remains to be identified. However, once discovered through the introduction of concrete examples, a standard method of solution to the students' problems will become known to both the student and to the teacher. There were no responses which reflected a problem of type 7.

According to Getzels (1964), type 8 problems can be described as the highest form of discovery. The use of this problem type requires processes of problem finding. Since, ill-defined problems provide the stimulus for processes of problem finding (Mackworth, 1965), and a relationship between problem finding and variables associated with creativity has been established in the literature (Arlin, 1975-76), the teacher whose response reflects this level of problem formulation may have the cognitive processes necessary for identifying the nature of her students' problems with instructional tasks from a developmental perspective. She may be able to identify and interpret students' "incorrect" responses to instructional tasks as ill-defined problem situations, that is, as problems which require further discovery and elaboration. Only one teacher provided a type 8 response:

> The questioner is asking her [Roberta] to give her information she cannot answer from the paragraph. He/she is asking Roberta questions that require prior knowledge inappropriate for a 7 year old to be expected to have. [see Appendix A, Scenario #3; see Table 5, Subject #13]

This teacher's response reflects her awareness that the student is having a problem with the instructional task. However, no immediate attempt to provide remediation is evident in her response. Furthermore, the teacher sees the instructional process as contributing to the problem, and indicates that the methods used were not matched to this particular student's developmental level or point-of-view. This teacher seems to leave the situation open to further discovery. The teacher who is able to identify students' "incorrect" responses to instructional tasks as ill-defined problem situations, may be using processes of problem finding in these types of situations in her own classroom.

Frequency of Problem Formulation by Subject Category/Grade Level

Table 7 provides a distribution of the ratings of problem formulation according to each teacher's selection of the anecdote which represented the subject category/grade level most familiar to or taught by the teacher. Familiarity with the subject category and grade level of students was viewed as likely to increase the opportunities for teachers to respond to situations so as to reveal the most adequate use of the experiences and actions, and cognitive processes available to them (Piaget, 1972; Sinnott, 1978; Sinnott & Guttmann, 1978).

Table 7: Frequency Table for Problem Formulation (PF) by Subject Category/Grade Level

PF Type*	Prim. Ma/Sc (n=7)	Prim. Hum/Soc (n=8)	Int. Ma/Sc (n=9)	Int. Hum/Soc (n=3)
8	--	1(2.5)**	--	--
7	--	--	--	--
6	1(14.3)	--	1(11.1)	--
5	--	--	--	--
4	--	--	1(11.1)	--
3	--	--	--	--
2	3(42.8)	4(57.1)	1(11.1)	1(33.3)
1	3(42.8)	3(37.5)	6(66.7)	2(66.6)

*Highest to Lowest Levels of Problem Formulation
**Number of responses(percentage of n)

As indicated in Table 7, the majority of responses are rated at levels 1 and 2 in all subject category/grade level groups. Although these results suggest that most of the teachers in the present study use a minimum of creative thinking or discovery when attempting to identify the student's problem, some teachers from each of the subject category/grade level groups (except Intermediate(Humanities/Social Studies))

engage in processes associated with problem finding at both the lowest (level 2) and highest (level 8) levels of problem formulation. No one group tends to score primarily high or low on problem formulation. Neither subject category nor grade level seem to contribute to the ways in which teachers identify students' problems in ill-defined problem situations.

2. Integrative Complexity

The second question posed to teachers in order to explore how they identify the student's point-of-view was, "What question(s) do you think this student was asking him/herself while working through the task? Why do you think so?" Teachers' responses to this question will be examined in terms of their concordance with modifications of the levels of integrative complexity (conceptual structure) delineated by Schroeder, Driver and Steufert (1967).

According to research on a developmental perspective, students provide correct answers to the questions they ask themselves about the problems presented to them for solution (Arlin, 1983; Sinclair & Kamii, 1970). It is the teacher's job to identify the problems and questions students have with instructional tasks. She needs to be able to formulate on-the-spot hypotheses about the way the student is thinking about something, that is, how the student's "incorrect" answer may be the "correct" answer for the question(s) the student asks him/herself. Table 8 provides a distribution of the ratings for the teacher's levels of integrative complexity (conceptual levels).

Table 8: Frequency Table for Integrative Complexity (IC)

IC Levels*	Frequency (n=27)	Percent
4	01	03.7
3	03	11.1
2	03	11.1
1	20	74.1

*4=High Integrative Complexity; 3=Moderately High Integrative Complexity; 2=Moderately Low Integrative Complexity; 1=Low Integrative Complexity

The large majority of responses reflect the lowest level of integrative complexity (level 1). From these responses it can be inferred that these teachers do not tend to generate alternative explanations about the kinds of questions the students may have been asking themselves as they were working through the instructional task. Of the 27 participants in the study, 20 or 74.1% responded at this low level of integrative complexity. The following is an example of a response rated at scale value 1:

> I think some [students] didn't ask themselves anything; they said the first thing that came to mind. I feel this way because many answers seem rote while others don't make sense. [see Appendix A, Scenario #5; see Table 5, Subject #17]

These teachers tend to use lower levels of conceptual processes to generate their responses. Their answers do not reflect an ability to take into consideration their own understanding of the problem situation as it differs from how the students are thinking in the same situation. They do not discriminate, differentiate or integrate this information in such a way as to take the students' points-of-view into account. Instead, teachers providing level 1 responses tend to attribute students' "incorrect"

answers to weaknesses in the students which are thought to be quickly remedied through the provision of appropriate information. They interpret the students' "incorrect" responses as "wrong". This suggests that the majority of teachers in the present study may not have the necessary cognitive processes for formulating alternatives about how their students construct their own knowlege about certain curriculum tasks.

Scale value 2 reflects a moderately low level of conceptual structure. It can be inferred from this level of teacher response that they have the ability to make some predictions about the similarities and differences between how the students were thinking while working through the task and how they themselves think about the same task. Of the 27 participants, only 3 or 11.1% of the responses were rated at this moderately low level of conceptual structure. An example is:

> What shape do I give the world? What goes in the middle? What's next to it (or me)? How does everything "fit"? [see Appendix A, Scenario #4; see Table 5, Subject #15]

A moderately high level of conceptual structure was reflected in 3 or 11.1% of the responses. An example of a level 3 response is:

> I think the students were simply asking themselves how many wheels they had because they were asked to <u>count</u> them. I do not believe the children understood that the numeral 16 could be broken up into tens and ones. [see Appendix A, Scenario #1; see Table 5, Subject #6]

This teacher appears to question whether or not the students actually understand the concept of place value. She leaves her initial hypothesis about how the students are thinking to further exploration and discovery and bases further analysis of the student's work on her resulting prediction that, "...the students were simply

asking themselves how many wheels they had...". Rather than attempting to "ward off" the problem, she keeps the problem situation open for further discovery by formulating alternative conceptions about how the students might have been thinking while working through the task. She integrates her own understanding of how the students' interpretations conflict with her own interpretations of the task at hand and indicates that there is a need to collect further information about the students' problems.

The one participant, whose response reflected a high level of integrative complexity (level 4), chose to complete a scenario from the Primary(Humanities/Social Studies) group. This teacher of 15 years, revealed in her questionnaire (see Appendix B), that she had taught English as well as programs for the gifted and talented to students in grades 3 to 6. The following is her response to question #2:

> I think Roberta is trying very hard to draw on prior knowledge and she is trying to concretize her answers to the question and draw on her experiences. [see Appendix A, Scenario #3; see Table 5, Subject #13]

It can be inferred from this response that this teacher is providing a theoretical description about how she thinks the student might have been thinking while working through the task. The response itself can be described as an hypothesis; one which allows the teacher the freedom to formulate alternative explanations through the processes of discrimination, differentiation and integration, and to generate further hypotheses from this information about the student's own thinking.

Within a cognitive developmental framework (Piaget, 1972), the ability to formulate hypotheses requires formal reasoning ability; a necessary but not sufficient condition

for problem finding (Arlin, 1975-76, 1977, 1986). Therefore, in addition to the way in which the teacher organizes information (conceptual level), the way in which the teacher abstracts or selects information from these alternatives (formal reasoning ability) may contribute, in part, to the way in which the teacher begins to identify the student's point-of-view in an ill-defined problem situation.

Within a problem finding framework, the ability to formulate hypotheses in ill-defined problem situations requires a high level of integration (Arlin, 1984). In addition, a high level of integration (Arlin, 1975-76, 1977, 1986) is required if the problem finding is to result in the 'general question', the outcome of problem finding (Arlin, 1975-76). It is interesting to note that this teacher (Subject #13) scored high on problem formulation (see Table 5). The suggestion is that if the teacher identifies the student's problem as ill-defined, thus initiating the processes of problem finding, she may also have the high levels of integration and abstraction required to identify and interpret the student's point-of-view in her own classroom.

Frequency of Integrative Complexity by Subject Category/Grade Level

Ratings of teachers' responses from all subject categories and grade levels indicate that the majority of teachers participating in the present study did not tend to generate alternative explanations or formulate hypotheses in order to predict how the students might have been thinking while working through the task. Table 9 provides a distribution of the levels of integrative complexity by the subject category and grade level selected by each teacher.

The distribution of teachers within each group does not suggest that subject category/grade level has a significant effect on level of integrative complexity. Neither subject nor grade seem to contribute to the extent to which the teacher formulates alternative explanations about the questions students ask themselves about particular curriculum tasks.

Table 9: Frequency Table for Integrative Complexity (IC) by Subject Category/Grade Level

IC Type*	Prim. Ma/Sc (n=7)	Prim. Hum/Soc (n=8)	Int. Ma/Sc (n=9)	Int. Hum/Soc (n=3)
4	----	1(12.5)**	----	---
3	1(14.3)	----	1(11.1)	---
2	----	2(25.0)	1(22.2)	1(33.3)
1	6(85.7)	5(62.5)	7(77.7)	2(66.6)

*4=High Integrative Complexity; 3=Moderately High Integrative Complexity; 2=Moderately Low Integrative Complexity; 1=Low Integrative Complexity
**Number of responses(percentage of n)

3. Quality of Point-of-View

In order to provide a direct exploration of how teachers identify the child's/adolescent's point-of-view when faced with classroom problems which are ill-defined problems, participants were asked, "What question(s) would you, as the teacher ask the student(s) about the problem(s) you think they are having with the task? What responses would you expect to get? Why do you think so?" This question was posed to teachers drawing on the developmental perspective literature (Arlin, 1983; Brooks, 1984) in which the formulation of "thoughtful questions", (Brooks, 1984) has been discussed as an essential instructional tool for eliciting on-going responses which reveal the students' points-of-view. The purpose of

eliciting these responses is to provide a means by which the teachers can verify or refute the hypotheses they formulate about the nature of the problems they think students are having with particular tasks.

Research suggests that the kinds of questions posed in ill-defined problem situations tend to approach what Mackworth (1965), in his information processing framework calls, the 'general question'. Within a problem finding framework (Arlin, 1975-76, 1977, 1986), the "mainline" processes required to formulate many general questions from many ill-defined problems include, differerentiation, discrimination and a high level of integration (Arlin, 1975-76; Schroeder, Driver & Steufert, 1967). In addition, the ability to select from available information, what is appropriate for "solving" the problem, requires a high level of formal operational thought (Arlin, 1984). The extent to which these processes are available to the teacher for use in ill-defined problem situations may influence the extent to which she is able to formulate the 'general question'.

The kinds of questions teachers ask in ill-defined problem situations will be examined in terms of their concordance with a modification of Guilford's (1956) six intellectual products categories as delineated by Arlin (1975-76, 1977) in her descriptions of problem finding. Each question posed by the teacher was rated according to the six categories (see Chapter 2) and the number of questions asked by each teacher was tallied. The quality of the questions posed by each teacher was calculated by obtaining the "weighted average" of the questions according to intellectual products category over the total number of questions asked by the participant (Arlin, 1975-76). This formula is illustrated in Figure 3 below:

Figure 3: Formula for Calculating Question Quality

$$\frac{1(cat) + 2(cat) + 3(cat) + 4(cat) + 5(cat) + 6(cat)}{\text{total number of questions asked}}$$

The following table provides a distribution of the categories of questions which represent quality of point-of-view:

Table 10: Frequency Table for Quality of Point-of-View (QP)

QP Category*	Frequency (n=27)	Percent
6	01	03.7
5	01	03.7
4	01	03.7
3	01	03.7
2	04	14.8
1	18	66.6
0	01	03.7

*6=implications; 5=transformations; 4=systems; 3=relations; 2=classes; 1=units; 0=no questions posed

As indicated in Table 10, the majority of questions teachers asked students about their problems were units questions. 18 or 66.6% of the teachers posed questions which reflect low levels of both information organization (differentiation, discrimination, integration) and abstraction (formal reasoning) (Arlin, 1977). The following example of a category one (units) response suggests that the teacher

thinks the student is having a problem with the task due to a lack of basic information required to provide the "correct" answer:

> Back up. What do [you] use fractions for? - [Student response] Don't know. [see Appendix A, Scenario #6; see Table 5, Subject #16]

No attempt to identify the student's point-of-view can be inferred from this teacher's response. He merely indicates, through direct observation, that the students lack knowledge of fractions. The information he elicits from the students is based on a literal interpretation of the problem.

Four or 14.8% of the teachers responded with questions in the classes category. It can be inferred from their responses that they attribute their students' problem(s) to slow learning and the need for specific remedial assistance. The following is an example of a Category 2 response:

> I would ask her [Roberta] to tell me what a town is, what a state is and what a country is. I would expect to get answers like -- "Where you live". "A place to live, but different from where I live." "Where different people live". I feel she would give these answers because of the responses she's given to specific town, state, and country questions. [see Appendix A, Scenario #3; see Table 5, Subject #10]

Only one of the 27 participants in the present study asked questions reflecting the relations category (3). This teacher suggests that there may be a relationship between the students' responses to the task and how the student understands the concepts relevant to the task:

> <u>The Problem Solving strategy</u> to be focused on: What do you know how to do with fractions? What is <u>different</u> about the new situation? How can you change the unfamiliar to the familiar? [see Appendix A, Scenario #6; see Table 5, Subject #22]

One participant posed questions reflecting the systems category (4):

> I wouldn't have asked her any of those questions [past] the 3rd one. I would have proceeded differently. I would have asked: Is Alabama in the United States? What is the United States? How is Wisconsin like Alabama? How is the place Caddie lives like the place you live? How is it different? Do you know the name that is given to the different parts of the United States where people live like Alabama, Wisconsin, Calif., N.Y., etc.? Do you know the name given to places where people live like Birmingham? I would never have introduced "country" and "town" in my questions. I think it confused her. I would have asked further questions about how countries are alike and different. Once introduced, I might have asked her what the difference between a town, and country were. [see Appendix A, Scenario #3; see Table 5, Subject #13]

This teacher conducts a task analysis which reveals how she thinks the student is organizing the information available to that student for generating a response to the task. The information the teacher collects may indicate the need for further questioning in order to verify or refute her hypotheses about the student's problem.

One teacher posed questions which reflects the ability to identify the student's point-of-view. The processes of discrimination, differentiation and the high level of integration required if the process of problem finding is to result in the 'general question' is evident in her response (Arlin, 1975-76):

> It depends greatly upon what has been previously introduced to the children. If this is a new topic of study I don't believe I would ask many questions except maybe to spark interest in the upcoming subject of place value. I might ask, "Why didn't you circle <u>all</u> of the wheels?", "If there are 16 wheels and I ask you to circle both numerals in this number, why haven't all of them been circled?" I would expect them to explain to me what they know about the values of <u>1</u> and <u>6</u>. Then this could lead to a discussion of <u>1</u> standing for 1 group instead of <u>1</u> object. [see Appendix A, Scenario #1; see Table 5, Subject #6]

This teacher goes beyond stating the question in the form of an hypothesis to integrating the hypothesis into her teaching. She may think about her own thinking and then reflect on this thinking while formulating questions to elicit responses from the students' points-of-view. This teacher may teach from a developmental perspective.

At the highest level of question quality, implications (6), one teacher posed the following question:

> First I would ask why they [students] think the answer they gave is correct. From their frame of reference, I'm sure their answer makes sense to them; their answer merely mirrors their reality of the matter. [see Appendix A, Scenario #7; see Table 5, Subject #21]

Research on problem finding (Arlin, 1977) indicates that implications questions require a high level of organization, that is, the teacher may be able to organize incoming information in such a way that a "general quality is abstracted that is not readily apparent in the stimuli" (p. 298). In other words, this teacher may have the processes available to her for reflecting on her own theories of teaching and learning and selecting information from these reflections according to the situation at hand. This notion is further enhanced by findings (Arlin, 1975-76) that, the ability to ask transformations (category 5) or implications (category 6) questions tends to reflect higher levels of abstraction than asking questions in other categories (Arlin, 1977, 1986; see Table 5, Subjects #6 and #21). Within a problem finding framework, the ability to formulate hypotheses based on the selection of appropriate information tends to be related to the use of abstract thought in ill-defined problem situations. The suggestion is that teachers who generate "many general questions from many ill-defined problems" may be facile in their use of formal

operational thought (Arlin, 1975-76). It is interesting to note that Subjects #6 and #21 receive high ratings on integrative complexity as well as on quality of point-of-view. Teachers who think about their own thinking (Piaget, 1972), think about doing something (Lampert, 1984) and think about doing something while doing it (Schon, 1983, 1987) may have the cognitive developmental processes available to them for "reflecting-in-action" on their own theories of teaching and learning. They may have the ability to teach from a developmental perspective.

Quality of Point-of-View by Subject Category/Grade Level

The following table provides a distribution of the quality of questions teachers asked by subject category and grade level:

Table 11: Frequency Table for Quality of Point-of-View (QP) by Subject Category/Grade Level

QP Type*	Prim. Ma/Sc (n=7)	Prim. Hum/Soc (n=8)	Int. Ma/Sc (n=9)	Int. Hum/Soc (n=3)
6	----	----	1(11.1)	----
5	1(14.3)	----	----	---
4	----	1(12.5)	----	---
3	----	----	1(11.1)	---
2	2(28.6)	2(25.0)	----	---
1	4(57.1)	4(57.1)	7(77.7)	3(100.0)
0	----	1(12.5)	----	----

*6=implications; 5=transformations; 4=systems; 3=relations; 2=classes; 1=units; 0=no questions posed

The majority of responses within each subject category and grade level were rated as units questions. No one group appears to have a significant number of high or

low ratings. From this observation, neither subject nor grade level seem to contribute to the extent to which teachers ask questions which elicit responses from the student's point-of-view.

The question quality score for the entire sample has been calculated below (see Figure 3 for the Question Quality Formula):

$$\frac{1(49) + 2(15) + 3(5) + 4(8) + 5(0) + 6(1)}{78 \text{ (total number of questions asked)}}$$

The question quality score for the 27 participants = 1.48

In the present study, an overall question quality score of 1.48 indicates that the teachers participating in the present study tend to pose questions which reflect the notion that the students' problems are due to a lack of basic information which may be quickly remediated once the appropriate information is provided. Within a problem finding framework (Arlin, 1975-76, 1977, 1986), this suggests that the majority of teachers in this study do not generate many general questions from many ill-defined problems in order to elicit ongoing responses from their students. Their responses do not reflect the discrimination, differentiation and integration necessary for generating alternatives about how the students are thinking about a curriculum task. Hypotheses based on the selection of information deemed appropriate for the situation are not formulated (Arlin, 1977). In other words, teachers in the present study may not have the processes associated with problem

finding and subsequent problem solving available to them for use in ill-defined problem situations. They may not "reflect-in-action" in the practice setting (Schön, 1983, 1987). In this view, the processes of discovery associated with high levels of 'problem formulation', 'integrative complexity' and 'quality of point-of-view' may be necessary but not sufficient conditions for the teacher to "reflect-in-action" (Schön, 1983, 1987) on her own theories of teaching, learning, instruction and education, and therefore to teach for thinking (Arlin, 1985) from a developmental perspective. The developmental teaching strategies that teachers use to assist students with their problems may provide further insight into this question.

4. Developmental Teaching Strategies

Teachers were asked to provide responses to the question, "How would you proceed to help this student with the problem(s) that you think he/she is having? What strategies would you use? Why?" Teachers' responses to this final question will be examined in terms of their concordance with the developmental teaching strategies delinated by Arlin (1983, 1986b).

One of the key elements in a constructivist view of thinking about teaching and teaching for thinking (Arlin, 1985, 1986b) involves knowledge of the implications of Piagetian and neo-Piagetian research for educational practice (Arlin, 1983) and knowledge of instructional strategies which provide an insight into "how" the student is thinking about a particular concept (Arlin, 1983, 1986b; Brooks, 1984). Teaching strategies which are based on a 'developmental perspective' represent only the beginning of teaching from the child's point-of-view:

> They represent first steps in coming to understand the thinking demands of tasks in the light of the logic of the students. The use of these strategies depends on teachers thinking about teaching and teaching for thinking. The use of these strategies involves an awareness of the types of thinking which many curriculum tasks require. (Arlin, 1986b, p. 20)

Developmental teaching strategies account for the student's point-of-view by providing a means by which the teacher can test her own theories about the problems she identifies her students as having with certain instructional tasks. They may influence the way in which she assists her students with instructional problems in the classroom. Table 12 provides a distribution of the number of different strategies that emerge in each teacher's discussion of procedures:

Table 12: Frequency Table for Developmental Teaching Strategies (DT)

DT Strategy*	Frequency (n=27)	Percent
1	05	18.5
2	04	14.8
3	23	85.2
4	03	11.1
Nil	03	11.1

*1=hypothesis generation; 2=framing; 3=concreteness principle; 4=examples continuum; 6=developmental teaching strategy not stated (See Chapter 3, Table 4, for a full description)

According to Table 12, of the entire sample of 27 teachers, 23 or 85.2% indicated that the provision of concrete objects or experiences to students was an effective strategy for assisting them with the problem(s) they were having with the instructional task. Twelve teachers suggested the use of concrete materials and/or experiences alone:

> [Concreteness Principle, Subject #10]: I would show her a map of the United States and explain what towns, states, and a country is. She at 7, would most likely not completely understand all the concepts involved. I would use a paper wall map, and a puzzle map to help her understand states and their relationship to each other. These would also help to show Roberta country and town relationships. Children need a variety of approaches and by being able to look at, and feel with her hands, this would give her the variety she needs. [see Appendix A, Scenario #3; see Table 5]

In only four instances was the 'concreteness' principle not included in the teacher's description:

Three teachers did not mention at least one of the developmental strategies in their responses:

> [Subject #8]: I don't know. [see Appendix A, Scenario #4; see Table 5]

> [Subject #1]: Take the 16 wheels and break them up into two groups - 10 and 6. Try to explain why the 1 is worth 10 when you have the total. Or try 10+1, 10+2, etc. [see Appendix A, Scenario #1, see Table 5]

> [Subject #25]: It would depend on the grade level, ability level, and interest and attitude level of the students involved. [see Appendix A, Scenario #8; see Table 5]

Only one teacher, who mentioned the strategy of 'hypothesis generation', did not suggest the use of the 'concreteness principle' in his response:

> [Subject #26]: It would appear that I could begin to evaluate strategies used to create the confusion and begin again. [see Appendix A, Scenario #8; see Table 5]

The remaining strategies of 'hypothesis generation', 'framing' and the 'examples continuum', were much less frequently mentioned. Of the 27 participants, only 5 or 18.5% of the teachers' responses indicated that they would formulate "on-the-spot"

hypotheses about the way the student was thinking about the task while providing assistance. Only 4 or 14.8% of the teachers indicated that they would conduct a conversation with the student about the task in order to collect further information about the student's thinking. And, only 3 or 18.5% of the participants indicated that they would use different examples in order to encourage concept development. These results may be related to observations that the majority of participants tended to receive consistently low ratings on problem formulation, integrative complexity and quality of point-of-view (see Table 5). Teachers who scored consistently low on all variables tended to identify the students' problems as known or well-defined. Their responses did not reflect the use of processes of problem finding or discovery to identify how the students were thinking about their problems. Therefore, it would be unlikely that these teachers would formulate their own theories of teaching and learning and reflect on these theories from a 'developmental perspective'.

Further examination of Table 12 reveals that teachers tended to either mention the use of concrete manipulatives and/or experiences exclusively or as one of a combination of different strategies. The following examples illustrate the 'concreteness principle' as it is combined with one or more of the remaining three strategies:

> [Concreteness Principle, Framing, Hypothesis Generation, Subject #9]: Roberta's responses to my questions would tell me which direction to go in next. I would continue with questions until I narrowed down enough facts to satisfy my suspicions as already stated. Continued dialogue is the most important strategy I could use...That would be another place to start with her; to point out the similarities we all have with each other. Map work is in order... [see Appendix A, Scenario #3; see Table 5]

> [Concreteness Principle, Examples Continuum, Framing; Subject #7]: I believe this student could be helped by going back to the initial steps in developing an understanding of the place value system. I would start

> with tens and ones and would progress through the developmental stages and use manipulations, then pictorial and finally symbolic representation of the numbers 0-19. I would question the student's understanding of the null or empty set and instruction on this concept if necessary...

Teachers who combined strategies did not tend to receive higher ratings on the other 3 variables than teachers who mentioned the 'concreteness principle' alone.

Distribution of Developmental Teaching Strategies

The following table provides a distribution of developmental teaching strategies by subject category/grade level. The number of teachers within each subject/grade level category who mentioned one or more of the strategies in their discussion of procedures is documented.

Table 13: Frequency Table for Developmental Teaching Strategies (DT) by Subject Category/Grade Level

Strategy*	Prim. Ma/Sc (n=7)	Prim. Hum/Soc (n=8)	Int. Ma/Sc (n=9)	Int. Hum/Soc (n=3)
1	2(28.6)**	2(25.0)	----	1(33.3)
2	1(14.3)	2(25.0)	1(11.1)	----
3	6(85.7)	7(87.5)	9(100.0)	1(33.3)
4	1(14.3)	2(25.0)	----	----
nil	1(14.3)	1(12.5)	----	1(33.3)

*1=hypothesis testing; 2=frames; 3=concreteness principle; 4=examples continuum (See Chapter 3, Table 4 for a full description)
**Responses(Percentage by n)

Although there does not appear to be a significant effect of subject category/grade level on the number of developmental teaching strategies mentioned, it is interesting to note that teachers in the intermediate groups tended to mention the

'concreteness' principle almost exclusively. This may be related to the nature of the subject matter and/or the grade level taught.

A comparison and examination of responses to question #4 by teachers rated low or moderately low and teachers rated high on problem formulation, integrative complexity and quality of point-of-view indicates that it may not be the types or number of different developmental teaching strategies that are important for discovering the problems and questions students have about certain instructional tasks, but rather **how** the teacher uses the strategy/ies to assist the students with their problems. The following two examples will be used to examine this observation: Subject #4 received low ratings on all variables while Subject #13 received high ratings (see Table 5):

> [Subject #4]: Place value work with the counting of real objects. This child should count out 1000 objects to get a "feel" for how much 1000 is. I would backtrack to an area of place value success (maybe 1's and ten's). Then work through several standard numbers with counters, occasionally leaving out a place (ex: 1000, 20, 4) and discussing "what happens". Child needs several experiences of this type until concept is "real". [see Appendix A, Scenario #2; see Table 5]

> [Subject #13]: I would have had maps and globes next to me to help her. I would have started with a map of Alabama and picked out Birmingham. Then I'd take out a US map and we'd find [Alabama] and Birmingham on the map. Then we'd look at a world map and find the U.S. Depending on how she reacted we could talk about how long it would take to get to Wisconsin from Birmingham walking, by car, by plane, etc. We could look at pictures, etc. [see Appendix A, Scenario #3; see Table 5]

Both of these teachers mention more than one strategy in their discussions of how they would assist the students with their problems. However, on close examination of their responses, the major question for consideration becomes, "How might these

teachers **use** these strategies in the practice context?" In other words, "How many different strategies **which can be defined as developmental teaching strategies** emerge in each teacher's discussion of procedures?" The following discussion will provide an insight into these questions.

From his discussion of strategies, it can be inferred that Subject #4 has established that the student's problem is in his/her understanding of the concept of place value and that the "counting of real objects" is the appropriate intervention. Based on this knowledge, this teacher proceeds to outline the specific steps he would take to make the concept "real" for the student. Although he seems to provide the student with opportunities to build up a repertoire of connections between the concept of place value and his/her experiences with counting real objects, this teacher does not suggest the need for alternative strategies in the event that the student continues to respond in "unexpected" ways even after exposed to "several experiences of this type". This teacher's assumption that the student will come to understand the concept of place value through predetermined teaching methods is further indicated in his final comment: "I have a problem with worksheets of this length. If a child can understand a concept + demonstrate such in 5 examples, say, why isn't this o.k.? It is for me!". What this suggests is that Subject #4 is more interested in knowing that the student can provide correct responses rather than in knowing how the student comes to understand the concept(s) associated with providing a "correct" response.

By contrast, Subject #13 indicates that she has some ideas about how she would proceed to assist the student with her problems, but does not explicitly state what

that problem is. For this teacher, the student's problem remains unknown. Using concrete materials, examples and discussion, the teacher conducts a conversation with the student which suggests an interest in collecting further information about how the student is thinking about the task. This teacher indicates that she is prepared to consider the student's point-of-view during instruction in her comment, "Depending on how she [Roberta] reacted,...[to initial instruction with maps and globes]...". She seems to leave her selection of strategies open to definition by discovering and framing them within the context of her teaching rather than, as in the case of Subject #4, using predefined strategies as a framework for her teaching. This teacher identifies the student's problem as one which requires further discovery and elaboration; she identifies this type of problem as an ill-defined problem. She may have the processes required to reflect on her own theories of teaching and learning and therefore formulate and select from her own repertoire, those strategies she sees as appropriate to the situation at hand (see Appendix A, Scenario #3). She may teach from a developmental perspective in her own classroom.

These inferences suggest that there may be a relationship between the processes associated with problem finding and the ability to formulate and reflect on strategies based on the construction of one's own knowledge. Upon examination of teachers' responses, those who received low ratings on problem formulation, integrative complexity and quality of point-of-view tended to describe methods indicative of well-defined teaching methods. They may have knowledge of development, but they may not reflect on this knowledge and use it to identify the student's point-of-view. Instead, these teachers may provide verbal descriptions of appropriate strategies, but may not use them when engaged in the act of teaching.

Themes which arose in these teachers' discussions of strategies included:

(a) presenting new information to students,

> [Subject #19]: If the explications kids gave above [to question #4] didn't lead to constructing a method which resulted in the traditional answer, I'd present new information using concrete materials...[see Appendix A, Scenario #6; see Table 5]

(b) covering steps missed in previous lessons and/or (c) starting from the beginning,

> [Subject #5]: I would teach place value strategies -- ones, tens, hundreds -- I would use manipulatives and place value cards to teach the concept, e.g. 95 is not the same as 905. The student needs to see the difference in concrete examples before he/she moves to abstract (i.e. expanded notation). [see Appendix A, Scenario #2; see Table 5]

(d) guiding students to the "correct" answer,

> [Subject #17]: I would start from scratch to teach the concept. I would use visual examples and hands-on activities to explain. This way I hopefully would cover the steps they missed in previous lessons. [see Appendix A, Scenario #5; see Table 5]

(e) reversing the process by attempting to "correct" the students' problem(s) before asking the students questions about their problem(s),

> [Subject #18]: I would have students (the moon) rotate in place with reference to teacher (as the sun) noting that their back was turned at one point. Then rotate always looking at one spot on the floor (move around it) noting they always <u>faced</u> the spot (earth) even though they were at some time back to the sun...Students will be helped with visual demonstrations and actual participation when teaching movement concepts such as this. [see Appendix A, Scenario #7; see Table 5]

Teachers who received low scores on all variables "knew that" a particular strategy can be used effectively while those teachers who received high ratings on all variables indicated that they "knew how" to use the strategies to assist the

students from their own points-of-view. Teachers' explanations about how they would **use** the strategy to assist their students provides additional insight into how a teacher constructs her own knowledge about teaching and learning based on a developmental perspective, and suggest how they might apply this knowledge to instructional situations. Only three responses indicated the use of a developmental perspective:

> [Subject #13]: As discussed in comparison with Subject #4.

> [Subject #6]: The children need practice finding sets of ten within a group of objects and then labeling the set as to how many groups of ten they found and how many were left over. Therefore, I would begin with manipulative objects and have each child "find ten" in each set and then tell me how many groups of ten he/she found and how many were left over. We would record these numerals on the board and then "guess" how many objects total were in that set. Ex: 1 ten and 3 ones is 13. [See Appendix A, Scenario #1; See Table 5]

> [Subject #21]: Having the students take part in a demonstration of this relationship - discussion on the topic - have the students draw diagrams of the process of the Earth & Moon. This would give the students an experiential base to work with. Any questions could be approached in the discussion. The students would do the diagram as an activity to use what they have just learned. [See Appendix A, Scenario #7; See Table 5]

Teachers who use strategies that assist students from the students' points-of-view are actively engaged in constructing their own theories of teaching and learning. They become active participants who define and interpret their own problems and questions in the practical setting rather than conforming to predefined methods and strategies. They become researchers in the classroom.

5. Other Variables of Interest to the Present Study

Participants in the present study completed a questionnaire which requested information regarding, (a) their concern for problem finding, represented by the question, "Why do you teach?", and (b) a variety of demographic variables. The questionnaire can be found in Appendix B.

a. Concern for Problem Finding

In their studies of problem finding in young artists, Getzels and Csiksentimihalyi (1976) provide evidence that in the face of discovered or ill-defined problems, individuals who view their work as an expression of known or felt things simply want to reproduce selected aspects of reality in pleasing ways. These individuals purposely adopt predefined problems on which to base their work by seeking out problems which have ready-made solutions. They tend to approach uncertainty with pre-formulated theories. By contrast, individuals who view their work as an expression of unknown things approach their work with a conscious need to formulate new theories which apply to unknown problems. They approach uncertainty with an overall concern for problem finding or discovery as a central purpose of their work. In the present study, participants' responses to the question, "Why do you teach?", will be examined in terms of their concordance with the teacher's overall concern for problem finding or discovery in the context of her work as modified and delineated by Getzels & Csiksentimihalyi (1976) (see Appendix B, Question #1). The teacher's own theory of teaching, learning, instruction and education may be related to the way in which teachers assist their students with the problem(s) they are having with instructional tasks.

Of the 27 participants in the present study, only 3 teachers provided responses which reflect a concern for discovery in their teaching:

> [Subject #13]: I have always found children to be fascinating. I'm never bored because I've never taught the same lesson twice the same way because the cast keeps changing. It's mentally stimulating and I grow and learn each year. [see Table 5 for cognitive process ratings]
>
> [Subject #6]: I enjoy finding different ways of helping children to grow and learn and achieve some success. I am rewarded by the enthusiasm that children have about learning. [see Table 5]
>
> [Subject #21]: I love working with children and am confident that I can provide child centred activities to foster their acquisition of knowledge. [see Table 5]

These teachers suggest that they receive rewards from their work, that is, from the process of teaching itself. It is interesting to note that these teachers received high ratings on problem formulation, integrative complexity and quality of point-of-view. In addition, the strategies they used to assist their students reflected the sense of discovery which goes along which teaching from a developmental perspective.

By contrast, the remainder of teachers' responses move increasingly toward a view of teaching in terms of the personal benefits obtained from teaching rather than the rewards which come from the teaching itself. The following examples illustrate this decreasing concern for problem finding:

> [Subject #11]: Because it's a joy to teach when you feel like you have or are making a difference in the learning or the way each child feels about him/herself and others. [see Table 5]
>
> [Subject #15]: It is the professional career I chose/backed into. I am continuing into my 24th year--beyond retirement age--because (1) it makes me feel "useful to society", (2) I still love children, (3) I still need the responding love of children, (4) I'm still working towards improving, perfecting my craft. [see Table 5]

> [Subject #25]: I enjoy working with young people, and wish to help them in ways similar to those that my teachers used to help me. I enjoy contact with young people both in and out of the classroom, contact which I think helps to keep me young and fresh in outlook. [see Table 5]
>
> [Subject #18]: I enjoy working with young people. [see Table 5]

These responses range from the satisfying feelings that come from observing the effects of one's teaching on students to descriptions of the satisfying feelings which come directly from the students. This is consistent with the lower ratings received by these teachers on problem formulation, integrative complexity and quality of point-of-view and their tendency to use direct teaching methods to assist students with their problems. These teachers seek rewards from helping their students acquire the knowledge that they themselves feel will benefit the students rather than seeking satisfaction from the process of discovery which comes from teaching from a developmental perspective.

Teachers whose theories of teaching reflect an overall concern for problem finding as a central purpose of their work tend to share a questioning attitude, an awareness that meaningful yet unresolved problems exist and a desire to identify such problems. They may identify the student's problem and seek its solution in the practical context.

b. Demographic Variables

Participants were asked to respond to a questionnaire which requested background information in areas related to children, teaching and educational practice (see Appendix B, Questions 2 through 7). This demographic information represents some of the knowledge of teaching and learning that participants may bring to bear on

present instructional situations. Of the 27 participants in the present study, 21 completed and returned the questionnaire. The following discussion will be limited to this portion of the entire population. The following is a summary and discussion of participants' responses:

1. Years of teaching experience ranged from 2 years to 24 years:

   0-5 years = 4 participants

   6-10 years = 3 participants

   11-15 years = 6 participants

   16-20 years = 6 participants

   21-25 years = 2 participants

   unknown = 6 participants

   The median years of teaching experience indicated by the 21 teachers who completed the questionnaire was approximately 14 years of experience. The mean number of years experience was 11.9 years.

2. Subjects taught varied among participants. Some taught a variety of subjects within one grade level (i.e., primary grades) while others taught one subject or several subjects at one or many grade levels.

   The main subjects taught by teachers in the humanities/social studies category included: spelling, reading, language and social studies. Social studies was being taught or had at some time been taught by more of the 21 teachers than any of the other subjects.

   Subjects taught within the Math/Science Category included math and science. More participants within this group indicated that they had taught math than science.

   Additional subjects included: physical education, health, art, religious studies,

special education classes, gifted and talented classes, career education and vocational education. Two participants mentioned their substitute teaching experience.

3. Grade levels taught by the 21 participants who filled out the questionnaire ranged from kindergarten to college classes:

   Kindergarten through grade 3 = 15 participants

   Grades 4 through 8 = 17 participants

   Grades 9 through 12 = 5 participants

   College Level = 1 participant

4. Other positions or experiences requiring direct intervention with children or adolescents have been summarized to represent the following categories:

   (a) extra-curricular school activities (student graduation; plays; out-trips)

   (b) coaching (field hockey; basketball; gymnastics)

   (c) volunteer work (aide in a religious education program; community service; cooperative volunteer work)

   (d) counsellor (camp counsellor; guidance counsellor)

   (e) parent

   (f) piano teacher

   (g) supervisor/leader (4-H leader; Bible school; playgound leader; student aide)

   (h) research technician

   Only one participant of the 21 who answered the questionnaire indicated the absence of additional experiences with children or adolescents.

5. Reasons for participating in the inservice course revealed two main themes:

   (a) an interest and desire to expand one's knowledge about teaching. Examples include: "...to gain knowledge and insight that will make learning

more productive for the students"; "...to help become a better teacher", and (b) required to attend inservice. Examples include: "...need [inservice] for 3 credits, will be required, not recommended"; "...signed up by principal although did not know what course was about"; "...school system requires it".

6. Familiarity with Piaget's work and its implications for classroom practice was generally expressed as "minimal". Most participants had been exposed to Piagetian theory in college, but had little recall of what they had learned. Participants who had some knowledge of Piaget's theories and their implications for educational practice revealed: "...much exposure in college as education major (project - studied children at each developmental stage, observed and recorded behavior, conducted Piagetian activities for data and interpreted results)"; "...4 day seminar on Piaget, Erickson, and Gesell / attained general knowledge"; "...have many books and articles on Piaget / can see evidence of levels of students in classroom therefore see and work with class differently now".

B. THE TEACHER'S POINT-OF-VIEW

The previous sections provided a discussion of each of the variables selected to explore how teachers identify the child's/adolescent's point-of-view when faced with classroom problems which may be described as ill-defined problems. A comparison of responses elicited from two participants in the study will provide a concise description of how there are differences between the ways in which teachers think when faced with the same classroom problem. Both teachers selected and completed the same scenario (see Appendix A, Scenario #1). Subject #1 received low ratings while Subject #6 received high ratings for problem formulation,

integrative complexity and quality of point-of-view. Strategies described by Subject #1 were based on pre-defined teaching strategies while those used by Subject #6 reflected the use of developmental teaching strategies. (see Table 5) The teachers' responses to each of the four questions posed in Scenario #1 are as follows:

Question #1: What kinds of problems do you think these students are having with this activity? Why do you think so?

Subject #1: They are having trouble with place value (10's).

Subject #6: The children appear to be having a problem transferring what they already know about numerals and their values to the new knowledge about how the values change according to the place of the numeral. They understand fully what the numeral one stands for but they have not understood what the numeral one stands for when it is in the tens place. They do not understand that 1 can be representing an entire group (one ten). They have learned how to count and record the number of objects in a group, but they have not yet learned how to think about the set in terms of subsets. I feel that at this point the students have not received enough practice in finding the groups of tens in a set and then labeling the set according to the ____tens & ____ones.

Question #2: What questions do you think these children were asking themselves as they worked through the assignment? Why do you think so?

Subject #1: Why isn't it worth "1"? Why isn't it correct - the one is on the left, I circled the 1st one on the left.

Subject #6: I think the students were simply asking themselves how many wheels they had because they were asked to count them. I do not believe the children understood that the numeral sixteen could be broken up into tens & ones.

Question #3: What questions would you, as the teacher, ask these children about the problems that you think they are having with this assignment? What responses would you expect to get? Why?

Subject #1: What does the 1 stand for in 16? "10"

Subject #6: It depends greatly upon what has been previously introduced to the children. If this is a new topic of study I don't believe I would ask many questions except maybe to spark interest in the upcoming subject of place value. I might ask, "Why didn't you circle all the wheels"?, "If there are 16 wheels & I ask you to circle both numerals in this number, why haven't all of them been circled?" I would expect them to explain to me what they know about the values of 1 & 6. Then this could lead to a discussion of 1 standing for 1 groups instead of 1 object.

Question #4: How would you proceed to help these children with the problem(s) they are having? What strategies would you use? Why?

Subject #1: Take the 16 wheels and break them up into two groups - 10 and 6. Try to explain why the 1 is worth 10 when you have the total. Or try 10+1, 10+2, etc.

Subject #6: The children need practice finding sets of ten within a group of objects and then labeling the set as to how many groups of ten they found and how many were left over. Therefore, I would begin with manipulative objects and have each child "find ten" in each set and then tell me how many groups of ten he/she found & how many were left over. We would record these numerals on the board & then "guess" how many objects total were in that set. Ex. 1 ten and 3 ones is 13.

These two teachers were presented with a classroom problem which may be described as an ill-defined or discovered problem. To this situation, each teacher brought her own repertoire of experiences and actions, her own frame for understanding the students' points-of-view and the cognitive developmental processes she had available to her for constructing her own knowledge about how the students understand the concept of "place value". Faced with the same classroom problem, each teacher identified and interpreted the situation differently:

Regarding question #1, Subject #1 indicates that the students are "having trouble with place value (10's)". This direct statement indicates that this teacher knows the exact nature of the students' problems. She does not appear to be aware that the students might have alternate conceptions about the concept of place value and therefore does not go beyond the students' "incorrect" answers to explore the "why" and the "how" of their responses. She does not elaborate on her response. This teacher interprets the students' responses as "wrong" and does not attend to the students' frameworks or points-of-view. For her, the students' problems are known or well-defined. By contrast, Subject #6 indicates that she is aware of the students' alternate conceptions of place value. She recognizes the discrepancy between her own definitions of the concept of place value, the definitions she expected from the students and the definitions she actually received. This teacher notices that the students do not understand the concept by elaborating on, rather than stating the nature of the problem: "The children appear to be having a problem transferring what they already know about numerals and their values to the new knowledge about how the values change according to the place of the numeral..." This teacher identifies and interprets the classroom problem as ill-defined, that is, as a problem situation which requires further discovery and elaboration.

Subject #1's response to question #2 indicates that she does not formulate alternative explanations about how the students might be thinking about the task. Instead, she attributes their "incorrect" responses to a lack of knowledge. This teacher indicates that this problem is easily remediated through the provision of appropriate information. This is evident in the questions she thinks the students were asking themselves as they were working through the task: "Why isn't it

correct - the one is on the left, I circled the 1st one on the left". This teacher does not appear to differentiate between how the students might have been thinking about the task and how she herself thinks about the same task. She makes predictions about how the students are thinking based on the experimentation (Mackworth, 1965) associated with solving rather than finding problems. By contrast, Subject #6 formulates an hypothesis about how the students' "incorrect" answers could be the "correct" answers for the students when she says, "I think....I do not believe....". These hypotheses about how the students might be thinking about the problem provide this teacher with ways of getting closer to "solving" the students' problems. In other words, the teacher attempts to "solve" the problem before attempting to find it (Arlin, 1975) by formulating hypotheses, based on alternative hypotheses, about how the students' thinking might differ from her own thinking in the same situation. She then integrates these hypotheses into her own thinking for their verification or refutation in the next step of the process.

Subject #1 does not appear to require verification of her responses. As indicated in question #3, this teacher identifies the students' problem as solved. She sees the solution of the students' problem as merely requiring the discovery of the answer that she originally expected. She initially identified the nature of the students' problems as one of "place value (10's)" (see Question #1), and proceeds to solve this problem by asking a question which is designed to elicit this same information: "What does the 1 stand for in 16?" She expects to get "10" as the response. Although this question may elicit different responses from the students, this teachers' expected answer of "10" suggests that other answers may not be acceptable to her. The processes of problem solving initiated by the identification of

the students' problem as well-defined are indicative of this type of response (Mackworth, 1965). Subject #1 does not appear to have the processes associated with problem finding that may be necessary for identifying and interpreting students' points-of-view in ill-defined problem situations. By contrast, Subject #6 formulates questions based on her hypotheses about how she thinks the students' are thinking about the task. With these questions, she elicits ongoing responses from her students in order to verify or refute her hypotheses and to collect further information about how the students may be thinking about the concept of place value: "...I might ask, "Why didn't you circle all the wheels"...?...I would expect them to explain to me what they know about the values of 1 and 6...". Subject #6 may have the processes associated with problem finding which may be necessary for identifying the students' points-of-view.

A key to identifying how a student has a concept is through the strategies one uses to assist the students with their problems. Subject #1 assists the students with the problem of place value by explaining "...why the 1 is worth 10 when you have the total...". This teacher merely provides new information and examples of the concept which the students may simply layer onto their alternative conceptions through memorization. This teacher knows that the students have a problem and knows that the strategies she has chosen will provide them with the information required to assist them with their problems. Subject #1 may base her teaching on pre-defined methods and strategies based on definitions of "good" teaching (Paley, 1986). Subject #6 mentions two developmental strategies in her response. These include: "frames" and "the concreteness principle". Her description of how she would assist the students with their problems reflects the sense of discovery which

goes along with identifying the student's point-of-view. She conducts a "conversation" with her students as they attempt to "'find ten" through the manipulation of objects. She keeps in touch with each student's frame of reference as she teaches. This teacher may formulate her own theories of teaching and learning while in the practice setting. She may teach from a developmental perspective.

The major difference between Subjects #1 and #6 is in their interpretations of the questions posed to them in the Student Anecdotes Task. Subject #1 comprehends the questions on a literal level only. The nature of her responses indicates that she may be constrained by the nature of the problem presented to her for solution and may also be constrained by the cognitive developmental processes available to her for organizing and abstracting her repertoire of experience and actions, the information appropriate to the situation at hand. By contrast, Subject #6 appears to comprehend the same questions on an abstract level. She may have the processes available to her for constructing her own knowledge of the student's point-of-view when faced with classroom problems which may be described as ill-defined problems.

The purpose of the present study was to generate questions based on the results discussed in this chapter. Further discussion of the results as they apply to the formulation of questions and the implications of these questions for research on teacher education and teacher thinking will be presented in Chapter 5. In addition, the limitations of the study and directions for future research will be discussed.

CHAPTER V. DISCUSSION

This study was designed to explore how teachers, when faced with classroom problems which may be described as ill-defined problems, identify the child's or adolescent's point-of-view. The extent to which the concept of teacher as problem finder describes those teachers who may have the structures and strategies necessary for reflecting on their own theories of teaching and learning in the practice setting was also examined. These questions were formulated from research on teacher thinking, problem finding and a developmental perspective on education. The major purpose of the study was to provide a framework from which questions, related to the extent to which teachers might teach from a developmental perspective in their own classrooms, could be delineated and further tested. Chapter 5 will provide a discussion of the results and limitations of the study as they contribute to the implications of and generation of future research questions on teacher education and teacher thinking.

A. DISCUSSION OF THE RESULTS

1. Problem Formulation

Classroom problems were redefined as ill-defined problems based on observations that students often respond to instructional tasks in ways that are "remarkably different from what the teacher would have expected" (Arlin, 1983; Brooks & Fusco, 1983) and on observations that teachers often treat ill-defined problem situations as well-defined problem situations (Getzels, 1964). Faced with a classroom scenario which represented an ill-defined problem situation, participants were asked to

respond to the question, "What kind(s) of problem(s) do you think this student is having with this instructional task? Why do you think so?" Responses were examined along a continuum of "presented" or "well-defined" and "discovered" or "ill-defined" problem situations each of which varied in what was known by the presenter/teacher and the solver/student in the classroom situation. Findings indicated that the majority of the 27 participants, 16 or 59.3%, responded at the lowest level (level 1) of problem formulation. These teachers identified the students' problems as well-defined. Processes associated with well-defined problems reflected a "minimum of innovation or creativeness" (Getzels, 1964). By contrast, levels 2 through 8 represented increasing levels of problem formulation. Nine, or 33.3% of the teachers provided level 2 responses, reflecting the lowest level of discovery associated with problem finding. One teacher provided a response associated with a level 4 problem type. Only 3 teachers provided responses indicative of the form of discovery associated with problem finding. These teachers identified the students' problems as open to further discovery and elaboration. Neither subject category nor grade level appeared to contribute significantly to level of problem formulation.

Within a problem finding framework, the ill-defined problem situation acts as a stimulus which initiates the problem finding process (Arlin, 1975-76, 1977, 1986; Mackworth, 1965). Within this framework, the extent to which the teachers identified the students' problems as ill-defined problems might be related to the extent to which they identify and interpret the students' points-of-view. If teachers identify students' "incorrect" responses as open to further discovery and elaboration, then they may have the cognitive processes necessary for teaching from a developmental perspective. These may include processes which are associated with problem finding:

integrative complexity and quality of point-of-view as well as developmental teaching strategies.

2. Integrative Complexity

In view of research which suggests that students correctly answer the questions they ask themselves (Arlin, 1983; Sinclair & Kamii, 1970), teachers were asked to respond to the question, "What questions do you think these students were asking themselves as they worked through this task? Why do you think so?" The suggestion was that teachers who formulate alternative explanations about the students' thinking as it differs from their own, might be using processes associated with problem finding and its subsequent problem solving. Studies of problem finding indicate that the processes of differentiation, discrimination and a high level of integration with respect to the stimuli or the ill-defined problem situation (i.e., classroom scenario) are required if problem finding is to result in a 'general question' (Mackworth, 1965), the outcome of problem finding (Arlin, 1975-76). This led to the suggestion that the way in which the teacher organizes information when faced with "unexpected" classroom problems or ill-defined problem situations, might be related to the extent to which he/she identifies the students' problems as ill-defined. It might also affect how the teacher identifies and interprets the students' problems and questions in these situations. This is suggested by Arlin's (1975-76) comment that,

> [t]he structural properties of differentiation, discrimination and integration characteristic of this process [of information processing] are analogous to the problem situation [i.e., ill-defined problem situation, and] the opportunity to raise questions [i.e., quality of point-of-view]... (Arlin, 1975-76, p. 101)

In addition to the formulation of alternative explanations, which requires a high level of integrative complexity (conceptual level), problem finding also involves "a selection from available stimuli according to some type of strategy" (Arlin, 1975-76, p. 101). Within a cognitive developmental framework, this process of selection occurs at the formal reasoning level (Arlin, 1984). Studies of problem finding indicate that formal operational reasoning is a necessary but not sufficient condition for problem finding (Arlin, 1975-76, 1977, 1986). At this level of thought, the teacher is able to select from her repertoire of experiences and actions, the information that she sees as appropriate to the situation at hand. Within a problem finding framework, how the teacher reflects on this information and uses it in an ill-defined problem situation may depend on the extent to which that teacher is a "good problem finder" (Arlin, 1975-76).

Results from the present study indicate that the large majority of teachers, 20 or 74.1%, provided responses which reflect the lowest level of integrative complexity (level 1). These teachers did not provide alternative explanations about how the students in the scenarios might have been thinking as they worked through the curriculum tasks. They did not appear to differentiate or discriminate between their own thinking about the task and the students' points-of-view. Three, or 11.1% of the teachers responded at both levels 2 and 3 of integrative complexity. Level 2 responses reflected an ability to interpret the students' questions in terms of similarities and differences in student and teacher thinking. Level 3 responses indicated the teachers' ability to integrate these alternative conceptions into their own thinking and to formulate questions based directly on these alternatives. Only one teacher's response (level 8) reflected this integration of alternatives (the teachers

thinking and the student's thinking) and the formulation of hypotheses which come from reflection on these alternatives. This teacher theorized as to "how" and "why" these similarities and differences exist:

> [Subject #13]: I think Roberta is trying very hard to draw on prior knowledge and she is trying to concretize her answers to the questions and draw on her experiences.

This teacher identified and interpreted the nature of this student's problem as ill-defined (see Table 5, Problem Formulation). It follows then, that if ill-defined problem situations initiate the problem finding process, the teacher who identifies and interprets students' "incorrect" responses as requiring further discovery and elaboration may seek alternative explanations about how the students are thinking about their problems. She may engage in processes related to high levels of integrative complexity which are indicative of problem finding. She may also engage in processes associated with problem solving (i.e., formal reasoning level) by abstracting from the available information that which she selects as appropriate to the situation.

The majority of teachers in the present study do not appear to be using processes associated with integrative complexity at levels high enough to begin to identify the questions and problems students may have with instructional tasks presented to them for solution. Neither subject category nor grade level appeared to contribute significantly to level of integrative complexity.

3. Quality of Point-of-View

The ability to ask questions which elicit ongoing response from students has been discussed as a key method for teaching from a developmental perspective (Brooks, 1984). In the present study, the kinds of questions posed in ill-defined problem situations were associated with the 'general question', the outcome of problem finding. Question quality scores were calculated according to the "weighted average" of the questions teachers posed when asked, "What questions would you ask the students about their problems? What responses would you expect to get? Why?". Ratings were based on Guilford's (1956) intellectual products categories which "represent the ways in which informational output is structured" (Arlin, 1975-76, p. 102). In the present study, transformations (category 6) and implications (category 7) questions were associated with the identification of the student's point-of-view. Neither subject category nor grade level appeared to contribute significantly to quality of point-of-view vis-à-vis question quality.

Teachers who received consistently low ratings on problem formulation and integrative complexity tended to receive low question quality scores. Eighteen, or 66.6% of the teachers received question quality scores at the units (1) level and 4, or 14.8% of the teachers received scores the classes (2) level. By contrast, those teachers who received consistently high ratings on problem formulation and integrative complexity received question quality scores at the transformations (5) and implications (6) levels. These findings are consistent with research on problem finding (Arlin, 1977) which suggests that implications questions require a high level of organization (i.e., integrative complexity) and abstraction (i.e., formal reasoning). Within a cognitive process model of problem finding (Arlin, 1975-76, 1986), question

quality scores below the categories of tranformations and implications are not indicative of the 'general question'. Only 2 teachers posed questions at this level of problem finding. It is interesting that Subject #13, who received the highest possible ratings on problem formulation and integrative complexity, received a question quality score at the systems (4) level. Her questions reflect the discrimination and differentiation associated with the formulation of alternative explanations about the student's problems. She formulates hypotheses about these differences and poses questions which are designed to collect further information about the students' thinking. However, this teacher does not pose questions which indicate that she goes beyond thinking about her own thinking to discover the "how" and the "why" of the students' responses. (see 'Limitations' section for a discussion of "maximum performance" as it applies to this situation)

The types of questions posed in ill-defined problem situations can be understood in terms of the developmental capacities the teacher brings to that situation. Problem finding has been referred to as a "critical process that links Piagetian operations to creative production" (Arlin, 1977, p. 297). This links formal reasoning to problem formulation. Further findings indicate that "operational level is related to the problem finding skill of posing general questions" (Arlin, 1977, p. 298). Studies of problem finding (Arlin, 1975-76, 1977, 1986) indicate that formal reasoning may be a necessary but not sufficient condition for problem finding and that transformations or implications questions do not appear below this level of reasoning.

The question quality score calculated for the entire sample was 1.48 which suggests that the majority of teachers in the present study tend to formulate questions

which are designed to elicit specific pre-defined responses from the students rather than questions which elicit ongoing responses from the students' points-of-view. It appears from these results that the extent to which the teacher has the processes of problem formulation, intregrative complexity and quality of point-of-view available to him/her for use in ill-defined problem situations may affect how each teacher identifies and interprets the student's point-of-view.

4. Developmental Teaching Strategies

Teachers were asked to discuss the strategies they would use to assist the students with the problems that they were having with the instructional tasks. In the present study, developmental teaching strategies accounted for the student's point-of-view by providing a means by which the teacher could test her own theories about the problems she identified her students as having with certain instructional tasks. Teaching strategies based on a developmental perspective represented only the beginning of teaching from the student's point-of-view (Arlin, 1983).

In the present study, 85.2% of the teachers mentioned the use of concrete materials as the major remedial strategy. 18.5% mentioned the strategy of 'hypothesis generation', 14.8% mentioned "framing" and 11.1% mentioned the 'examples continuum' (see Chapter 3, Table 4 for a description of the strategies). Three teachers did not mention strategies which represent any of the four developmental teaching strategies described in Chapter 3. Examination of teachers' responses indicated that the number of strategies mentioned by each teacher did not appear to be related to the way in which teachers described their use. Rather, descriptions ranged from the direct provision of appropriate information with or

without student participation to attempts at discovering the students' problems and questions while interacting with students. These descriptions are consistent with teachers who received consistently low ratings and those who received consistently high ratings, respectively, on problem formulation, integrative complexity and quality of point-of-view (see Table 5).

Consideration of the processes associated with reflection in adolescence and adulthood may provide an insight into the kind of reflection-in-action that the teacher engages in when constructing her own knowledge of teaching and learning. Research on postformal thought in adulthood argues for a structural model of adult thinking which involves a relativity of thought as opposed to the hypothetico-deductive thought found in adolescence (Arlin, 1984). Within this postformal thinking model, Arlin (1984) suggests that,

> ...[teachers] may not only exhibit competencies and skills in one area that are typical of one set of operations, but also exhibit quite a different set of competencies and skills in another. The choice of competencies and skills is dependent on the ...[teacher's] perception, selection, and/or construction of a particular problem space or spaces and the priority given them. The behaviors observed and the sequences of actions selected are, in this view, the direct result of the choice of the [teacher]. (Arlin, 1984, p. 261)

In the present study, teachers who were rated at low levels of problem formulation, integrative complexity and quality of point-of-view may be constrained by the experiences and actions and the cognitive processes available to them for identifying the student's point-of-view in ill-defined problem situations. They may be reflecting on their own observations or experiences of previous teaching success and applying this knowledge directly to new situations. By contrast, teachers who received high ratings on all variables, suggest in their responses that they select

from their repertoire of experiences and actions, previous information that they modify and integrate into the new situation. If teachers go beyond thinking about their own thinking (Lampert, 1984; Piaget, 1978) and thinking about doing something (Yinger, 1980) to thinking about doing something while doing it (Schön, 1983, 1987), then they may "reflect-in-action" (Schön, 1983, 1987) on their own theories of teaching and learning in their own classrooms.

B. LIMITATIONS OF THE STUDY

Several methodological issues including the generalizability of results, the use of classroom simulations as a measure of teacher thinking and the conclusions which can be drawn from the results require careful consideration.

The present study was exploratory only. Its intention was to generate questions based on the development of a framework for teacher thinking which combines several research traditions. These traditions are reflective thinking, cognitive development and problem finding. The sample for the present study was made up of a total of 27 experienced teachers participating in district-sponsored in-service courses designed to introduce teachers to a developmental perspective on education. Participants were not randomly selected, therefore generalizations to other teachers and to other teacher education programs must be considered with caution. Although the size of the sample was adequate for the exploratory nature of the study, the number of participants within each subject category/grade level varied. Only 3 teachers selected scenarios which represented the Intermediate(Humanities/Social Studies) group. Therefore, the effect of subject category/grade level on the main variables of problem formulation, integrative complexity and quality of point-of-view

as well as the developmental teaching strategies could not be empirically established. However, in view of the exploratory nature of the study, it can be inferred through close examination of the frequency tables, that neither subject nor grade level appear to contribute significantly to the teacher's ability to identify the student's point-of-view when faced with classroom problems which may be described as ill-defined problems.

The use of classroom simulations/scenarios to stimulate teachers' thinking about the problems and questions students have with instructional tasks gives rise to several methodological concerns. Each scenario was based on a teacher's own telling of a classroom situation where students reponded to an instructional task in ways which deviated from the teacher's original expectations. The scenarios represented a way of stimulating thought processes associated with problem finding and its subsequent problem solving, and provided opportunities for teachers in the present study to reveal their own thinking about the students' points-of-view. Each scenario was accompanied by a standardized answer sheet which was used to elicit responses and elaborations from the teachers. The form of questioning was based on the Piagetian clinical method. Although the use of a paper-and-pencil task does not achieve the quality of responses and explanations that are elicited by Piaget's clinical method within an interview setting, factors such as cost, time, economy of administration and the exploratory nature of the study influenced the method employed. Although the task was developed on the basis of sound research, the following observations and limitations must be carefully considered prior to its further use:

Discrepancies in the consistency of responses to questions 1 through 4 of the response sheet were identified in two cases. Subjects #17 and #20 provided responses to questions #1 and #2 of Scenario #6 (see Appendix A) which reflected low levels of problem formulation and integrative complexity. Neither teacher indicated the use of the 'concreteness' principle as a method of intervention for question #4. Furthermore, neither teacher indicated a concern for problem finding in his/her responses to the question, "Why do you teach?" Responses reflecting consistently low ratings on the main variables would normally be indicative of a low question quality score. However, the subjects' responses to question #3, are characteristic of systems and transformations questions:

> Question #1: What kinds of problems do you think these students having with this assignment? Why do you think so?
>
> [Subject #17]: They have no idea what a fraction is. The significance of the numerator and denominator are not understood.
>
> [Subject #20]: Knowing which number to add, try to figure out Lowest Common Denominator. I know by looking at their work and their answers.
>
> Question #2: What questions would you ask these students about the problems they are having with this task? What responses would you expect? Why?
>
> [Subject #17]: 1. I'd ask "How did you get that answer?" or "What makes you think that?" 2. I'd probably get some "justification" for the answer although it might be misdirected. Or, I might get an answer that applies to another concept. Perhaps the student just confused terminology.
>
> [Subject #20]: Would you please tell me how you got your answer? All kinds. Because they're each making sense of the problem in their own ways (although there may be some "stabs in the dark").

These teachers' responses to question #3, as compared to question #1 are indicative of the kinds of questions posed in ill-defined problem situations. In the

present study, these situations require processes of problem finding in order to result in the 'general question'. Unlike the consistently high level ratings received by some participants on all questions, these teachers' responses to question #3 do not correspond with their responses to question #1. Their responses to question #1 are indicative of well-defined problems which suggests that both teachers tend to interpret the questions on a literal level only. In addition, the two week time period allotted to participants for the completion of the task may have affected the responses. This is suggested in Subject #20's response to Question #7 of the Questionnaire (see Appendix B) regarding his familiarity with Piagetian theory and its implications for educational practice: "Almost completely unfamiliar, but that's changing quickly with the readings assigned." There may be a problem of subjects verbalizing appropriate or anticipated responses and these responses having little effect upon practice (Arlin, 1984).

Some teachers provided responses and elaborations for each question, while others provided responses alone. All participants who received consistently high ratings on all variables elaborated on their responses as did many with consistently low scores. Therefore, the ratings received do not appear to be affected by whether or not teachers elaborated on their responses. The amount of time given to complete the task, the teachers' interest in completing the task, the fact that the in-service was compulsory, and the possibility of teachers providing answers that researchers want to hear are some variables which might have affected the nature of the responses given by the teachers.

On two occasions, teachers seemed to interpret the question differently than was intended:

> Question #2: What questions would you ask these students about the problems they are having with this task? What responses would you expect? Why?
>
> [Subject #24]: If my assumptions of memorizing a rule is correct, these students would want to be spoonfed another rule to apply to unlike fraction addition. [see Appendix A, Scenario #6]
>
> [Subject #19]: I would suspect that the child who said, "I don't know" would have a question on how to compute the answer but the others may have no questions at all. [see Appendix A, Scenario #6]

These teachers might be providing responses to the questions they asked themselves, such as, "What questions would the students ask their teacher about the task? What responses would they expect? Why do you think so?" It is interesting to note that Subjects #17 and #20 from the previous discussion, and Subjects #24 and #19 from the present discussion, all chose Scenario #6 from the subject area and grade level group, Intermediate(Math). The problem might be related to the scenario or to question #3 itself. Although two other teachers responded to Scenario #6 without evidence of problems, the present findings suggest the need to examine the design of this particular scenario. This observation points to the need for direct clinical interviews complemented by classroom observations.

Clinical interviews which probe for information based on teachers' immediate reactions to the scenarios may provide a standardized way for controlling variations which seem to arise due to the flexibility of time given to complete the task. More importantly, the opportunity for the interviewer to elicit continuous responses

from each teacher will help to determine how the teacher is interpreting the question posed as well as how he/she is thinking about the task. In this situation, the interviewer is able to ask as many questions deemed necessary in order to elicit the teacher's framework. Ratings based on Piagetian clinical interview methods rather than on simulations and paper-and-pencil responses tend to result in more reliable and valid responses.

In addition, the extent to which the teacher reflects on his/her own construction of knowledge (experiences and actions), formulates his/her own theories of teaching and learning based on this knowledge, and then uses this knowledge in the classroom setting must be established through classroom observation. In the present study, the suggestion is that teachers who score high on all variables may have the processes associated with problem finding available to them for organizing and reflecting-in-action on their own knowledge within the practice setting. The extent to which teachers reflect on their "knowledge-in-action" may depend on the structures and strategies they have available to them for teaching from a developmental perspective. This may redefine the role of the teacher as problem finder. Evidence for this may best be established through clinical interview techniques augmented by careful classroom observation.

It is interesting to note that the kind of developmental teaching strategy most often mentioned by teachers at the intermediate grade levels was the 'concreteness' principle, while other strategies, combined with the concreteness principle, tended to be concentrated in the primary groups (see Chapter 3, Table 13). A higher sample size and the inclusion of senior level teachers may provide further insight into the

possibility that the focus of the teaching and the grade level may affect the extent to which the processes used by the teacher are, in fact, being used at their maximum levels. It has been suggested that the higher the grade level and the more the subject matter taught is related to the physical sciences and mathematics, the more likely the teacher will use direct teaching strategies than teachers at other grade levels who teach humanities/social studies courses.

The notion in studies of postformal thinking or problem finding in adults (Arlin, 1984) that "[t]he state that one has attained sets limits on maximum performance...[i]t has little to say about minimum performance" (Arlin, 1984, p. 261; Biggs & Collis, 1980), may provide an insight into some of the discrepancies in results. An example of the use of processes that reflect a lower level of performance than is suggested by other responses can be found in the ratings given to Subject #13 (see Table 5). This teacher was rated at the highest possible levels of problem formulation and integrative complexity. All four strategies were used as developmental teaching strategies in her discussion of intervention. This would normally suggest that the quality of questions posed by the teacher would be at the level of transformations or implications. However, the quality of the questions used to elicit the student's point-of-view reflected the systems category. This suggests that this teacher's questions might be based on verbal hypotheses rather than on the integration of these hypotheses into her own thinking. Another explanation is that this teacher might have formulated and selected her questions on the basis of previous hypotheses about how the student was thinking in order to ask questions which matched the student's level of thought. This could have been determined through an interview.

Despite these limitations, several implications and questions for future research on teaching emerged from the findings. These will now be discussed.

C. IMPLICATIONS FOR RESEARCH ON TEACHING

Studies of teachers and their teaching based on cognitive developmental models of adult thinking (see Glassberg & Sprinthall, 1980; Sprinthall & Sprinthall 1983a, 1983b) tend to be based on the behaviors, skills and attitudes that are assumed to be necessary for teachers to teach their students to think. What these researchers neglect to consider are the implications of a developmental perspective and a problem finding framework for studies of teacher thinking. Within a constructivist framework of growth in knowledge, researchers have the opportunity to examine how teachers think about teaching and learning. The teacher's own experiences and actions, and the cognitive developmental processes which may be associated with his/her ability to think about teaching and teach for thinking from a developmental perspective (Arlin, 1983, 1985; Brooks, 1984; Brooks, Fusco & Grennon, 1984; Elkind, 1976; Feldman, 1981) may provide researchers with an insight into the teacher's own "reflection-in-action". The concept of "teacher as problem finder" may provide an interesting metaphor for further research on teacher thinking and for the development of teacher education programs for both in-service and pre-service teachers.

If researchers begin to study the teacher as one who identifies his/her own problems and questions and who seeks her own solutions within the practical context, then they may begin to understand "how" and "why" teachers perform as they do. If researchers ask questions about the teacher's own thinking, then they

may begin to match teacher education curriculum to the needs of the teachers. If they begin to observe teachers in the act of teaching, then they may begin to identify the nature of the problems teachers face as they engage in the teaching process. In this view, teacher education will begin where the teacher is rather than on where researchers and teacher educators think the teacher "ought to be". What the present study may offer the researcher and teacher educator is a 'developmental perspective' and techniques for identifying and interpreting the teacher's own view of reality when she is faced with classroom problems which may be defined as ill-defined problems.

D. DIRECTIONS FOR FUTURE RESEARCH

The intent of the present study was to generate questions based on an exploration of the cognitive processes proposed to describe how teachers, when faced with classroom situations, identify and interpret the problems and questions students have with instructional tasks. As a result of the findings, several questions were generated to stimulate further research on, "Teaching from the student's point-of-view: A developmental perspective". These questions are:

1. To what extent do teachers identify students' "unexpected" reponses to what teachers believe to be well-defined instructional tasks as ill-defined problems?

   When faced with classroom situations which may be described as ill-defined problems,

   a. To what extent do teachers formulate alternative explanations about how their students understand a particular concept in ways which differ from how the teachers themselves understand the same concept?

      and

      To what extent do teachers select information from their repertoire of experiences and actions and formulate hypotheses based on these

alternatives in order to begin the process of identifying the student's point-of-view?

b. To what extent do teachers formulate questions based on their hypotheses about how the students are thinking? Do they elicit ongoing responses from the students? Do they verify or refute their hypotheses about how the students "have the concept"?

c. To what extent do teachers formulate their own theories of teaching and learning in order to begin to assist students with their problems and questions from the students' own points-of-view?

It follows from these questions that a problem finding framework which informs the teacher's "reflection-in-action" and which describes the steps a teacher goes through in making sense of an ill-defined problem situation may describe the teacher as problem finder in her own classroom:

1. To what extent does the cognitive process variable of problem formulation contribute to the teacher's ability to identify classroom problems as ill-defined problems?

   When faced with a classroom problem which may be described as an ill-defined problem,

   a. What cognitive process variables (integrative complexity, formal reasoning level, quality of point-of-view vis-à-vis question quality, developmental teaching strategies), singly or in combination, best predict the teacher's ability to identify the student's point-of-view when faced with classroom problems which may be described as ill-defined problems?

   b. To what extent do the cognitive process variables (integrative complex complexity, formal reasoning level, quality of point-of-view vis-à-vis question quality, developmental teaching stragies) describe those teachers who have the structures and strategies available to them for "reflecting-in-action" on their own theories of teaching and learning in their own classrooms?

REFERENCES

Arlin, P. K. (1975-76). A cognitive process model of problem finding. Educational Horizons, 54, 99-106.

Arlin, P. K. (1977). Piagetian operations in problem finding. Developmental Psychology, 13, 297-298.

Arlin, P. K. (1983). Cognitive levels matching: An instructional model and a model of teacher change. Journal of Children in Contemporary Society, 12, 99-109.

Arlin, P. K. (1984). Adolescent and adult thought: A structural interpretation. In M. L. Commons, F. A. Richards & C. Armon (Eds.), Beyond formal operations: Late adolescent and adult cognitive development (pp. 258-271). New York: Praeger Publishers.

Arlin, P. K. (1985). Teaching thinking: A developmental perspective. Impact on Instructional Improvement, 19(3), 25-29.

Arlin, P. K. (1986a). Problem finding and young adult cognition. In R. A. Mines & K. S. Kitchener (Eds.), Adult cognitive development (pp. 22-32). New York: Praeger Publishers.

Arlin, P. K. (1986b). Teaching for formal reasoning. The Board of Education for the City of Toronto.

Arlin, P. K. (in press). Problem solving and problem finding in young artists and young scientists. In M. Commons & C. Armon (Eds.), Beyond formal operations II. New York: Praeger.

Arlin, P. K. & Levitt, L. N. (1986). The teacher as developmental psychologist. Unpublished manuscript, University of British Columbia, Department of Educational Psychology and Special Education, Vancouver.

Bagenstos, N. (1975). The teacher as inquirer. The Educational Forum, 39, 231-237.

Biggs, J. B. & Collis, K. F. (Eds.). (1980). Cognitive development and instruction. New York: Holt, Rinehart, and Winston.

Brooks, M. (1984). A constructivist approach to staff development. Educational Leadership, 42, 23-27.

Brooks, M. & Fusco, E. (1983). Constructivism and education: The child's point-of-view. Journal of Children in Contemporary Society, 12, 111-132.

Brooks, M., Fusco, E. & Grennon, J. (1983). Cognitive levels matching. Educational Leadership, 40, 4-8.

Bruner, J. (1973). Beyond the information given. New York: Norton.

Case, R. (1978). A developmentally based theory and technology of instruction. Review of Educational Research, 48(3), 439-463.

Case, R. (1980). Implications of neo-Piagetian theory for improving the design of instruction. In J. B. Biggs and K. F. Collis (Eds.), Cognitive development and instruction (pp. 161-186). New York: Academic Press.

Clark, C. M. & Yinger, R. J. (1977). Research on teacher thinking. Curriculum Inquiry, 7(4), 279-304.

Dewey, J. (1933). How we think: A restatement of the relation of reflective thinking to the educative process. Boston: D.C. Heath and Company.

Dewey, J. (1977). The relation of theory to practice. In J. Boydston (Ed.), John Dewey: The middle works, 1899-1924 (Vol. 3, pp. 249-272). Southern Illinois University Press: Feffer & Simons, Inc. (Original work published 1904)

Dillon, J. T. (1982). Problem finding and solving. The Journal of Creative Behavior, 16(2), 97-111.

Driver, R. & Easley, J. (1978). Pupils and paradigms: A review of literature related to concept development in adolescent science students. Studies in Science Education, 5, 61-84.

Elkind, D. (1976). Child development in educational settings. Educational Psychologist, 12(1), 49-58.

Elliot, J. (1975-76). Developing hypotheses about classrooms from teachers' personal constructs. Interchange, 7, 1-22.

Erickson, G. L. (1987, April). Constructivist epistemology and the professional development of teachers. Paper presented at the annual meeting of the American Educational Research Association, Washington, D.C.

Feiman, S. (1979). Techniques and inquiry in teacher education: A curricular case study. Curriculum Inquiry, 9, 63-69.

Feldman, D. H. (1981). Beyond universals: Toward a developmental psychology of education. Educational Researcher, 10, 21-26, 30-31.

Furth, H. G. (1981). Piaget and knowledge (2nd ed.). Chicago: The University of Chicago Press.

Gallagher, J. M. (1977). Reflective abstraction and education. In J. M. Gallagher & J. A. Easley (Eds.), Knowledge and development. Vol. 2: Piaget and education (pp. 1-20). New York: Plenum, Inc.

Gallagher, J. M. & Reid, D. K. (1981). The learning theory of Piaget and Inhelder. Monterey, California: Brooks/Cole Publishing Company.

Getzels, J. W. (1964). Creative thinking, problem solving and instruction. In E. Hilgard (Ed.), The sixty-third yearbook of the national society for the study of education theories of learning and instruction. Chicago: University of Chicago Press.

Getzels, J. W. & Csiksentimihalyi, M. (1976). The creative vision: A longitudinal study of problem finding in art. New York: Wiley.

Getzels, J. W. & Dillon, J. T. (1973). The nature of giftedness and the education of the gifted. In R. M. W. Travers (Ed.), Second handbook of research on teaching. Chicago: Rand McNally.

Glassberg, S. & Sprinthall, N. A. (1980). Student teaching: A developmental approach. Journal of Teacher Education, 31, 31-38.

Goodman, J. (1984). Reflection and teacher education: A case study and theoretical analysis. Interchange, 15(3), 9-26.

Grennon, J. (1984). Making sense of student thinking. Educational Leadership, 42, 11-16.

Guilford, J. P. (1956). The structure of the intellect. Psychological Bulletin, 53, 267-293.

Hullfish, H. G. & Smith, P. G. (1961). Reflective thinking: The method of education. New York: Dodd, Mead & Company.

Hunt, D. (1980). Teachers' adaptations: 'Reading' and 'flexing' to students. In B. Joyce, C. Brown & L. Peck (Eds.), Flexibility in teaching. New York: Longmans.

Hunt, J. M. (1961). Intelligence and experience. New York: Ronald Press.

Inhelder, B. & Piaget, J. (1958). The growth of logical thinking from childhood to adolescence. London: Routledge & Kegan Paul.

Joyce, B. (1972). The teacher innovator: A program for preparing educators. In B. Joyce & M. Weils (Eds.), Perspectives for reform in teacher education. Englewood Cliffs, N.J.: Prentice-Hall.

Kamii, C. (1985). Young children reinvent arithmetic. New York: Teachers College Press.

Karmiloff-Smith, A. & Inhelder, B. (1974-75). If you want to get ahead, get a theory. Cognition, 3, 95-112.

Kitchener, K. S. (1983). Educational goals and contemporary models of reflective thinking. Educational Forum, 48, 75-95.

Kohlberg, L (1969). Stage and sequence: The cognitive developmental approach to socialization. In D. Goslin (Ed.), Handbook of socialization theory and research. Chicago: Rand McNally.

Lampert, M. (1984). Teaching about thinking and thinking about teaching. Journal of Curriculum Studies, 16(1), 1-18.

Larsen, G. Y. (1977). Methodology in developmental psychology: An examination of research on Piagetian theory. Child Development, 48, 1160-1166.

Levitt, L. N. & Arlin, P. K. (1986). The student anecdotes task. Unpublished protocol set, University of British Columbia, Department of Educational Psychology and Special Education, Vancouver.

Loevinger, J. (1966). The meaning and measurement of ego development. American Psychologist, 21, 195-206.

Mackworth, N. H. (1965). Originality. American Psychologist, 20, 51-56.

McNally, D. W. (1977). Piaget, education and teaching. Sussex: The Harvester Press Limited.

Neimark, E. (1982). Cognitive development in adulthood: Using what you've got. In T. M. Field, A. Huston, H. C. Quay, Y. Troll & G. E. Finley (Eds.), Review of human development (pp. 435-446). New York: John Wiley & Sons, Inc.

Oja, S. N. & Ham, M. C. (1984). A cognitive developmental approach to collaborative action research with teachers. Teachers College Record, 86, 171-192.

Paley, V. G. (1986). On listening to what the children say. Harvard Educational Review, 56, 152-169.

Perry, W. G. (1970). Forms of intellectual and ethical development in the college years. New York: Holt, Rinehart & Winston.

Phillips, D. C. (1980). What do the researcher and the practitioner have to offer each other? Educational Researcher, 9, 17-20, 24.

Piaget, J. (1972). Intellectual evolution from adolescence to adulthood. Human Development, 15, 1-12.

Piaget, J. (1978). Success and Understanding. Cambridge: Harvard University Press.

Piaget, J. (1979). Experiments in contradiction. Cambridge: Harvard University Press.

Salzillo, F. & VanFleet, A. (1977). Student teaching and teaching education: A sociological model for change. Journal of Teacher Education, 28, 27-31.

Schön, D. A. (1983). The reflective practitioner. New York: Basic Books, Inc.

Schön, D. A. (1987). Educating the reflective practitioner. San Franscisco: Jossey-Bass Publishers.

Schroeder, H., Driver, J. & Steufert, S. (1967). Human information processing. New York: Holt, Rinehart & Winston.

Selman, R. L. (1980). The growth of interpersonal understanding. New York: Academic Press.

Shulman, L. S. (1965). Seeking styles and individual differences in patterns of inquiry. School Review, 73, 258-266.

Shulman, L. S. (1986). Those who understand knowledge and growth in teaching. Educational Researcher, 15(2), 4-14.

Sigel, I. (1984). A constructivist perspective for teaching thinking. Educational Leadership, 41, 18-20.

Sinclair, J. & Kamii, C. (1970). The implications of Piaget's theory for the teaching of young children. School Review, 78, 169-183.

Sinnott, J. D. (1975). Everyday thinking and Piagetian operativity in adults. Human Development, 18, 430 433.

Sinnott, J. D. (1981). The theory of relativity: A metatheory for development? Human Development, 24, 293-311.

Sinnott, J. D. (1983). Post-formal reasoning: The relativistic stage. In L. Commons, F. A. Richards & C. Armon (Eds.), Beyond formal operations: Late adolescent and adult cognitive development. New York: Praeger.

Sinnott, J. D. & Guttman, D. (1978). Piagetian logical abilities and older adults' abilities to solve everyday problems. Human Development, 21, 327-333.

Smock, C. D. (1981). Constructivism and educational practice. In I. E. Sigel, D. M. Brodzinsky & R. M. Golinkoff (Eds.), New directions in Piagetian theory and practice. Hillsdale, N.J.: Lawrence Erlbaum Associates.

Sprinthall, N. A. & Thies-Sprinthall, L. (1983a). A need for theoretical frameworks in educating teachers: A cognitive developmental perspective. In K. R. Howey & W. Gardner (Eds.), The education of teachers (pp. 74-97). New York: Longman, Inc.

Sprinthall, N. A. & Thies-Sprinthall, L. (1983b). The teacher as an adult learner: A cognitive-developmental view. In G. Griffith (Ed.), Staff development (pp. 13-35). Chicago: National Society for the Study of Education.

Stratemeyer, F. B. (1965). Issues and problems in teacher education. In D. P. Cottrell (Ed.), Teacher education for a free people. New York: The American Association of Colleges for Teacher Education.

Strauss, S. (1981) Cognitive development in school and out. Cognition, 10, 295-300.

Thies-Sprinthall, L. (1984). Promoting the developmental growth of supervising teachers: Theory, research programs and implications. Journal of Teacher Education, 35, 53-60.

Walters, S. & Strivers, E. (1977). The relation of student teachers' classroom behavior and Eriksonian ego identity. Journal of Teacher Education, 38, 47-50.

Wood, P. K. (1983). Inquiring systems and problem structure: Implications for cognitive development. Human Development, 26, 249-265.

Yinger, R. J. (1980). A study of teacher planning. The Elementary School Journal, 80(3), 80-96.

Zeichner, K. (1981). Reflective teaching and field-based experience in teacher education. Interchange, 12, 1-22.

Zeichner, K. (1983). Alternative paradigms of teacher education. Journal of Teacher Education, 34, 3-9.

APPENDIX A

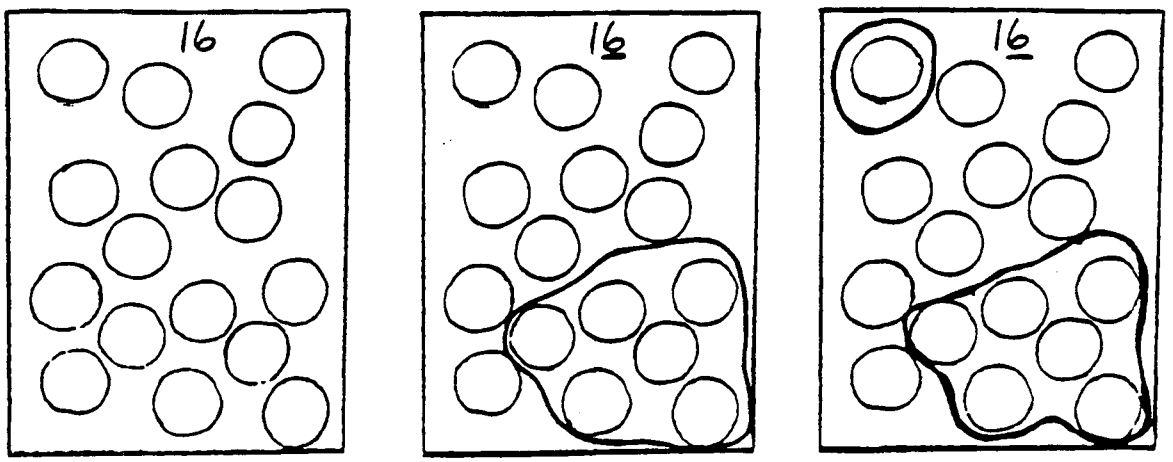
THE STUDENT ANECDOTES TASK

(Levitt & Arlin, 1986)

SCENARIO #1: PRIMARY (Grades K-3) - MATH
(adapted by P. K. Arlin, May 1986 from Kamii, C., 1985, pp. 60-61)

Near the end of the school year, first graders were given the following activity to do in their math lesson:

The children were each given a piece of paper, 16 tinker toy wheels and were asked to take out their crayons. The children were **not** told that there were 16 wheels. Rather, they were asked to take each wheel and draw an outline of it on their paper. After they had completed their outlining, they were asked to count up the number of wheels that they had drawn and to write the number on their paper as shown in Drawing A below. Then the children were asked by their teacher to circle the number of wheels that the **6** showed in the number "16". As the teacher gave these instructions, she underlined the "6" in the number "16". Drawing B shows the completed activity. Then the teacher asked the children to now circle the number of wheels that the **1** stood for in the number "16" on their papers. 32-out-of-32 children completed the task as shown in Drawing C.



A B C

Name: _____

ANSWER SHEET - (PRIMARY/Math)

Imagining that you are the teacher in this situation please answer the following questions as thoroughly as you can: (Feel free to use the back of the page if necessary)

1. What kinds of problems do you think these children are having with this assignment? Why do you think so?

2. What questions do you think these children were asking themselves as they worked through the assignment? Why do you think so?

3. What question(s) would you, as the teacher, ask these children about the problems that you think they are having with this assignment? What responses would you expect to get? Why?

4. How would you proceed to help these children with the problems they are having? What strategies would you use? Why?

SCENARIO #2: PRIMARY (Grades K-3) - MATH
(C. Reynolds, personal communication, October 1984)

The following worksheet on finding the standard number was completed by a grade 3 student at the beginning of the school year and was marked by the teacher. Please examine the worksheet carefully and answer the questions on the following page.

6X

Directions: Write the standard number.

1) 3000 + 200 + 20 + 6 = 3226
2) 6000 + 500 + 2 = 652X
3) 2000 + 0 + 0 + 9 = 2009
4) 800 + 30 + 7 = 837
5) 7000 + 900 + 90 + 1 = 7991
6) 1000 + 200 + 80 + 0 = 1280
7) 3000 + 200 + 10 + 7 = 3217
8) 9000 + 100 + 8 = 918X
9) 1000 + 700 + 60 = 176X
10) 3000 + 300 + 70 + 8 = 3378
11) 200 + 10 + 7 = 217
12) 8000 + 3 = 83X

13) 4000 + 100 + 30 + 7 = 4137
14) 1000 + 500 + 8 = 168X
15) 700 + 50 + 6 = 756
16) 4000 + 60 + 3 = 463X
17) 7000 + 700 + 50 + 6 = 7756
18) 200 + 90 + 5 = 295
19) 700 + 20 + 5 = 725
20) 5000 + 400 + 50 + 8 = 5458
21) 2000 + 600 + 10 + 9 = 2619
22) 8000 + 300 + 60 + 2 = 8362
23) 500 + 30 + 1 = 531
24) 800 + 70 + 7 = 877
25) 800 + 60 + 6 = 866

Name: _____

ANSWER SHEET - (PRIMARY/Math)

Imagining that you are the teacher in this situation, please answer the following questions as thoroughly as you can: (Feel free to use the back of the page if necessary)

1. What kind(s) of problem(s) do you think this grade 3 student is having with this assignment? Why do you think so?

2. What question(s) do you think this student was asking him/herself while working through the assignment? Why do you think so?

3. What question(s) would you, as the teacher, ask this student about the problem(s) that you think he/she is having with the assignment? What responses would you expect to get? Why do you think so?

4. How would you proceed to help this student with the problem(s) he/she is having? What strategies would you use? Why?

SCENARIO #3: PRIMARY (Grades K-3) - READING/SOCIAL STUDIES
(P. Arlin, personal communication, April 1986)

A bright 7 year old from Alabama named Roberta was interviewed by her teacher about the main character in the book called **Caddie Woodlawn** which she had just completed reading.

Prior to the interview, Roberta was asked to reread the introductory paragraph of the book:

> In 1864 Caddie Woodlawn was eleven, and as wild a little tomboy as ever ran the wood of western Wisconsin. She was the despair of her mother and of her elder sister Clara. But her father watched her with a little shine of pride in his eyes, and her brothers accepted her as one of themselves without a question. Indeed, Tom, who was two years older and Warren, who was two years younger than Caddie, needed Caddie to link them together into an inseparable trio. Together they got in and out of more scrapes and adventures than any one of them could have imagined alone. And in those pioneer days Wisconsin offered plenty of opportunities for adventure to three wide-eyed, red-headed youngsters.

Roberta was then asked the following questions about where Caddie Woodlawn lived while being allowed to reread the text as many times as she wanted. The following interview took place---

Interviewer: Where did Caddie Woodlawn live?

Roberta: In Wisconsin.

Interviewer: Is that in another country or is it in America?

Roberta: In America---is that right?

Interviewer: Why do you think it is in America?

Roberta: I know Wisconsin is a place in America.

Interviewer: Is it a country?

Roberta: Yes---is it?

Interviewer: Is it a town?

Roberta: No, it's like where we live in Alabama but different.

Interviewer: Is it like where you live?

Roberta: Yes, sort of but not all countries are alike---they have some thing different. If you are born in Wisconsin you aren't an Alabamian.

Interviewer: Is Wisconsin in the city or in the country?

Roberta: It is in the country because there is a farm in the picture and Caddie must live there.

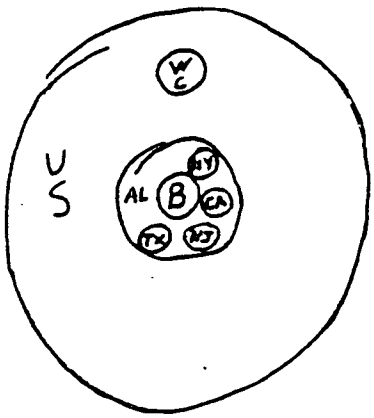
Before continuing, please answer the following question in the space provided below: *What do Roberta's answers reveal about her understanding of where Caddie Woodlawn lived?*

To get a more explicit description, Roberta was asked to illustrate where Caddie Woodlawn lived. The final product is shown below. Initially, the interviewer had drawn a circle on a blank sheet of paper to represent Birmingham. Roberta was then asked to **draw in Alabama.** As can be seen from her drawing on the next page, she drew a circle around Birmingham and labeled it 'AL'.

When asked to **draw the United States**, Roberta drew an even larger circle and labeled it 'US'.

On request, Roberta drew a small circle for **Wisconsin** in the United States and marked it "WC". Following this, she was asked to think of another place to put on her map. She selected **New Jersey** and drew a little circle in Alabama outside Birmingham to show its location. She continued placing California, Texas, and New York within little circles inside Alabama. When she was asked if New York was a city or a state, she said that is was a city.

Using the space provided below, please answer the following question with respect to the map Roberta drew: *Why do you think Roberta drew that map this way?*



Name: _____

ANSWER SHEET - (PRIMARY/Reading/Social Studies)

Imagining that you are the teacher in this situation, please answer the following questions as thoroughly as possible: (Feel free to use the back of the page if necessary)

1. What kind(s) of problem(s) do you think Roberta is having with this lesson? Why do you think so?

2. What question(s) do you think Roberta was asking herself as she formulated her responses? Why do you think so?

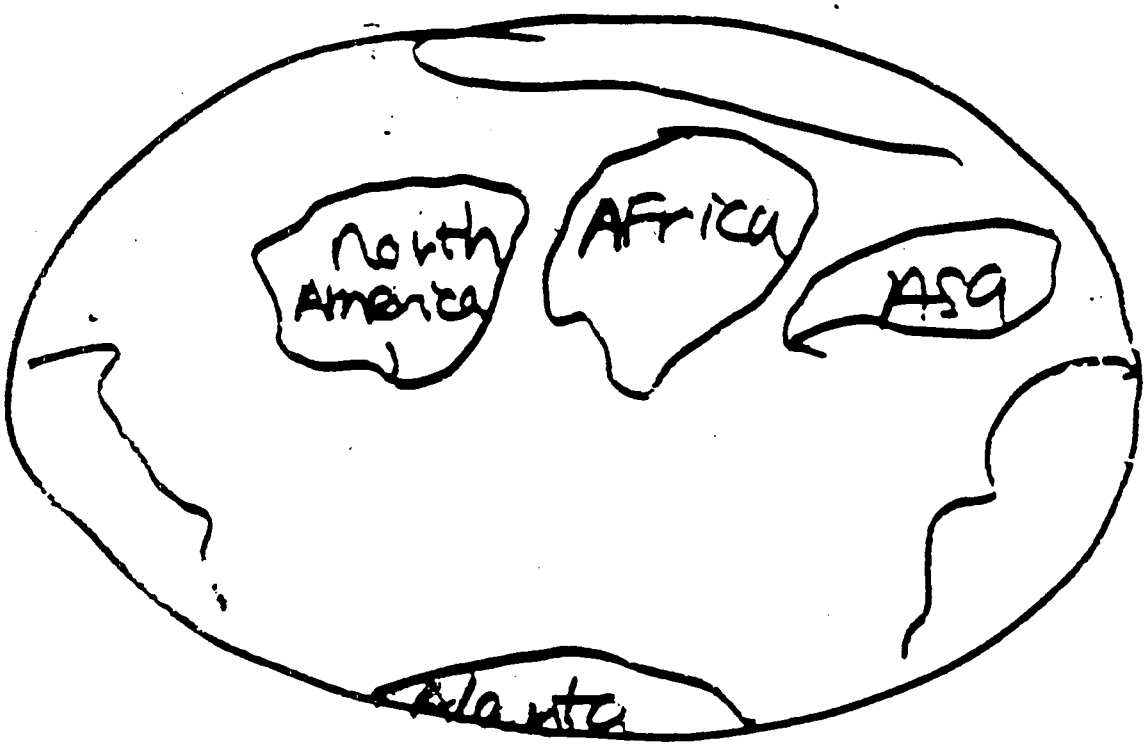
3. What question(s) would you, as the teacher, ask Roberta about the problem(s) that you think she is having with this lesson? What responses would you expect to get? Why do you think so?

4. How would you proceed to help Roberta with the problem(s) she is having? What strategies would you use? Why?

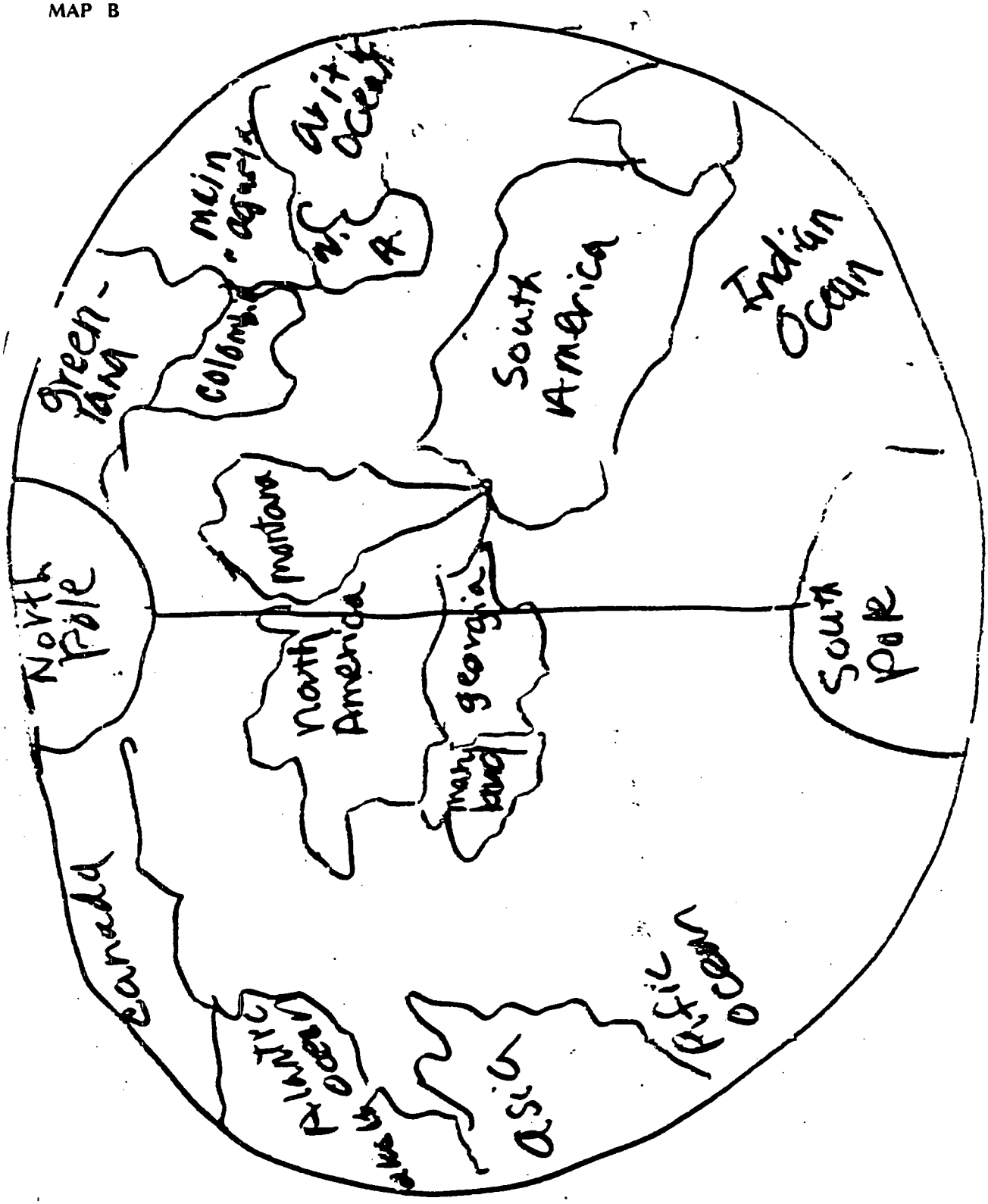
SCENARIO #4: PRIMARY (Grades K-3) - SOCIAL STUDIES
(A. Goran & B. Davis, personal communication, December 1986)

Students in Social Studies classes in a school district in Maine were given a blank sheet of paper and were asked to draw a map of the world. Below are samples of the maps submitted by various students. Please examine the maps carefully and on the answer sheet provided, indicate the grade level of the student that you think each map came from and why you think so:

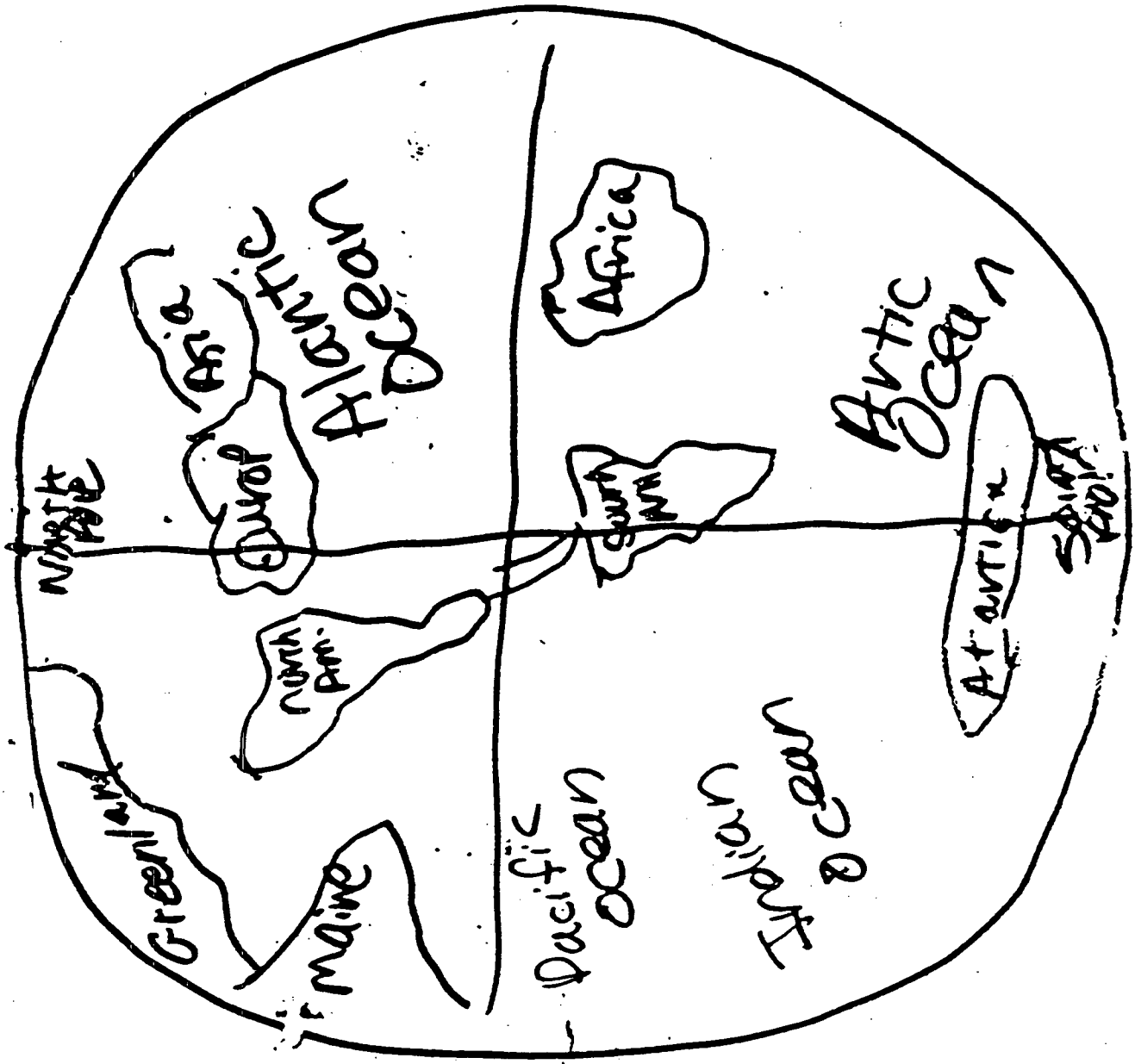
MAP A



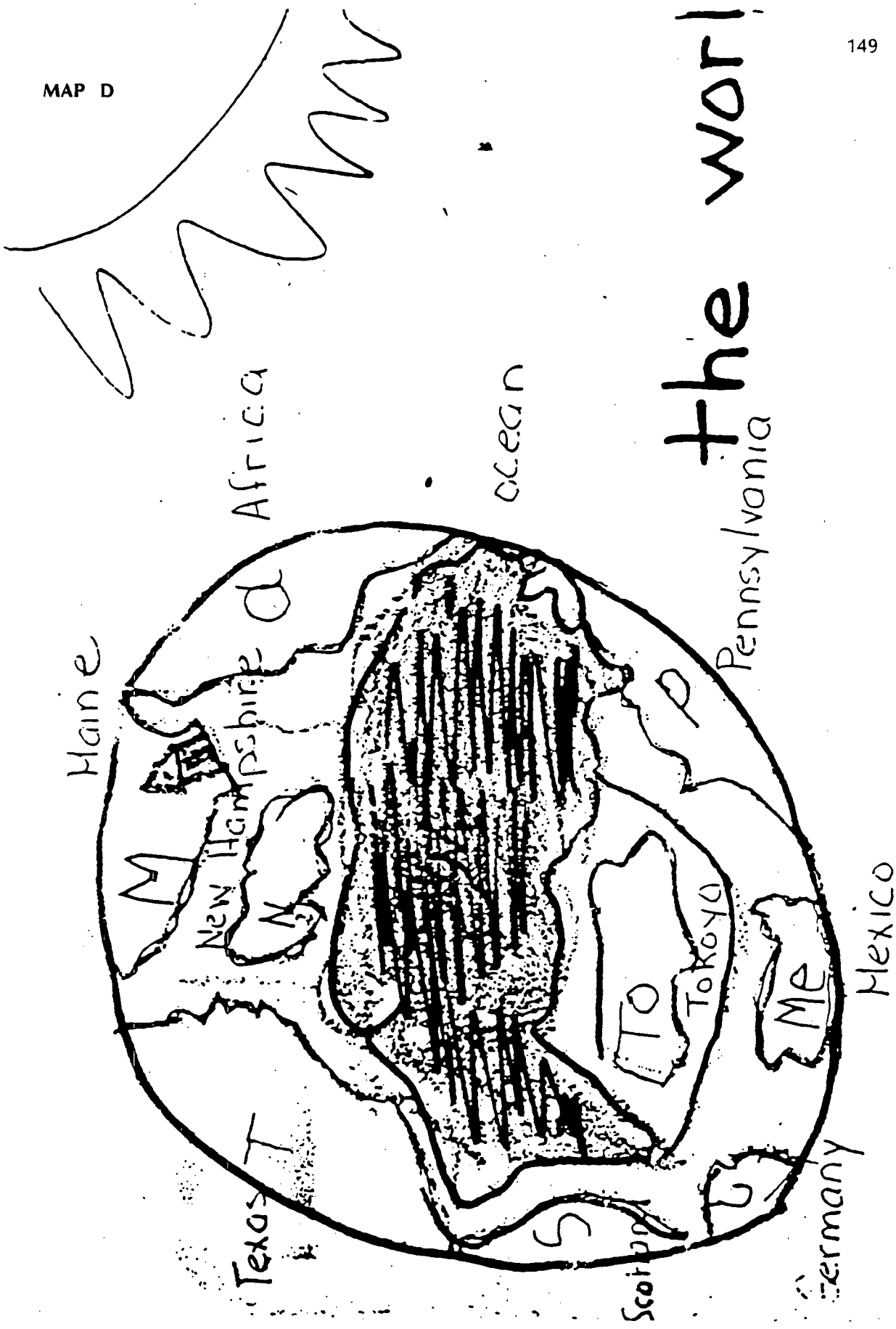
MAP B


North Pole
Green-land
Canada
Colombia
Main
Atlantic Ocean
Pacific Ocean
Asia
North America
Montana
Georgia
South America
Indian Ocean
South Pole

MAP C


Greenland
Alaska
Asia
Europe
North America
Atlantic Ocean
Africa
South America
Pacific Ocean
Indian Ocean
Antarctica
Arctic Ocean

MAP D


the worl
Africa
ocean
Maine
New Hampshire
Pennsylvania
Tokoyo
Mexico
Texas
Scotland
Germany


Alaska
Can.
Greenland
USSR
USA
Mex
Atlantic Ocean
Moscow
AF.
So. Am.
Australia
Pacific

MAP E

Name: _____

ANSWER SHEET - (PRIMARY/Social Studies)

Please indicate the grade level of the child you think each map came from and why you think so:

Map A

Map B

Map C

Map D

Map E

Imagining that you are the teacher in this situation, please answer the following questions regarding the map drawing task and the grade level(s) you assigned to each: (Feel free to use the back of the page if necessary)

1. What kinds of problems do you think these students are having with this assignment? Why do you think so?

2. What questions do you think these children were asking themselves as they worked through the assignment? Why do you think so?

3. What question(s) would you, as the teacher, ask these children about the problems that you think they are having with the assignment? What responses would you expect to get? Why do you think so?

4. How would you proceed to help these children with the problems they are having? What strategies would you use? Why?

Name: _____

SCENARIO #5: INTERMEDIATE (Grades 4-8) - MATH
(B. Brown & L. Stofan, personal communication, February 1984)

Students in grades 3 and 6 gave the following responses to the question, **WHAT IS A FRACTION?** Please read through the responses carefully, and beside each one, indicate whether you think the response was given by a grade 3 or by a grade 6 student and why you think so.

(a) Part of an object that is broken in pieces

(b) Numbers that tell you different things like if a ruler looks like just a bunch of lines, its a bunch of fractions and you need to know them

(c) Half of a whole number

(d) The number on top is the number of pieces from the bottom

(e) Part of a whole thing (such as a pizza)

(f) A piece of a "hole" thing

(g) Part of something

(h) Part of a whole

(i) Two numbers or more divided into two or more parts

(j) A whole number divided into separate pieces of numbers

(k) A math problem that you might solve in steps

(l) A number over another number

(m) Tells if something is even or not

(n) Numbers which tell you how many are colored and how many are not

(o) Part of something

(p) Something you use to count how many halves

(q) Equal parts

(r) Something which makes a sentence shorter -- instead of saying four parts and three are colored, its easier to say 3/4

Name: _____

ANSWER SHEET - (INTERMEDIATE/Math)

Imagining that you are the teacher in this situation and with regard to the answers you think were given by grade 3 and grade 6 students, please answer the following questions as thoroughly as possible: (Feel free to use the back of the page if necessary)

1. What kinds of problems do you think these students are having with the concept of "fraction"? Why do you think so?

2. What questions do you think these students were asking themselves as they formulated their responses? Why do you think so?

3. What question(s) would you, as the teacher, ask these students about the problems that you think they are having with fractions? What kind of responses would you expect to get? Why do you think so?

4. How would you proceed to help these students with the problems they are having? What strategies would you use? Why?

SCENARIO #6: INTERMEDIATE (Grades 4-8) - MATH
(N. Carroll, personal communication, May 1986)

Students in a grade 4 math class were given a worksheet on the addition of fractions having unlike denominators. Prior to this assignment, students had been taught equivalent fractions and the addition of fractions with similar denominators. The present assignment was preceded with a review of the addition of fractions with like denominators.

The students were given the following problem to solve: $\frac{1}{2} + \frac{1}{4} =$ _____.

These were their answers:

1. I don't know.

2. $\frac{1}{2} + \frac{1}{4} = \frac{2}{4}$

3. $\frac{1}{2} + \frac{1}{4} = \frac{1}{4} + \frac{1}{4} = \frac{2}{4}$

4. $\frac{1}{2} + \frac{1}{4} = \frac{1 - 1}{4 - 2} = \frac{0}{2}$

5. $\frac{1}{2} + \frac{1}{4} = \frac{1}{6}$

6. $\frac{1}{4} + \frac{1}{2} = \frac{1 + 1}{4 \div 2} = \frac{2}{2}$

7. $\frac{1}{2} + \frac{1}{4} = \frac{2 + 1}{4 - 3} = \frac{3}{3}$

8. $\frac{1}{2} + \frac{1}{4} = \frac{2}{1} + \frac{4}{1} = \frac{6}{1}$

9. $\frac{1}{2} + \frac{1}{4} = \frac{2}{2}$

10. $\frac{1}{2} + \frac{1}{4} = \frac{2}{6} + \frac{2}{6} = \frac{4}{6}$

11. $\frac{1}{2} + \frac{1}{4} = \frac{2 + 1}{4 - 3} = \frac{2}{1}$

12. $\frac{1}{2} + \frac{1}{4} = \frac{1 + 1}{2 \times 4} = \frac{2}{8}$

Name: _____

ANSWER SHEET - (INTERMEDIATE/Math)

Imagining that you are the teacher in this situation, please answer the following questions as thoroughly as you can: (Feel free to use the back of the page if necessary)

1. What kinds of problems do you think these students are having with this assignment? Why do you think so?

2. What questions do you think these children were asking themselves as they worked through the assignment? Why do you think so?

3. What question(s) would you, as the teacher, ask these children about the problems that you think they are having with the assignment? What responses would you expect to get? Why do you think so?

4. How would you proceed to help these children with the problems they are having? What strategies would you use? Why?

SCENARIO #7: INTERMEDIATE (Grades 4-8) - SCIENCE
(N. Darling, personal communication, April 1983)

In a grade 7 general science class of average to high average ability, the teacher posed the following question to her students after giving a brief lesson on the relationship between the earth and the moon:

> *Why do you think we always see the same side (near side) of the moon from the earth (no matter where we are on the earth)?*

The following responses were given by different students in the class:

- "One side is facing space and we get stuck with just one side."
- "Because when it is daytime it is on the other side."
- "Because that side always faces the sun."
- "I think we always see the same side of the moon because when we rotate and the moon rotates, by the time it gets dark out it is back where it was before."
- "Because the moon rotates one way and we rotate the other way so when we see it it is always the same side."
- "We always see the same side because the sun never shines on one side."
- "Because we move at the same time and speed as the moon does and that's why."
- "Because the moon is moving with us."

Name: _____

ANSWER SHEET - (INTERMEDIATE/Science)

Imagining that you are the teacher in this situation, please answer the following questions as thoroughly as you can: (Feel free to use the back of the page if necessary)

1. What kinds of problems do you think these students are having with this assignment? Why do you think so?

2. What questions do you think these students were asking themselves as they worked through the assignment? Why do you think so?

3. What question(s) would you, as the teacher, ask these students about the problems that you think they are having with the assignment? What responses would you expect to get? Why do you think so?

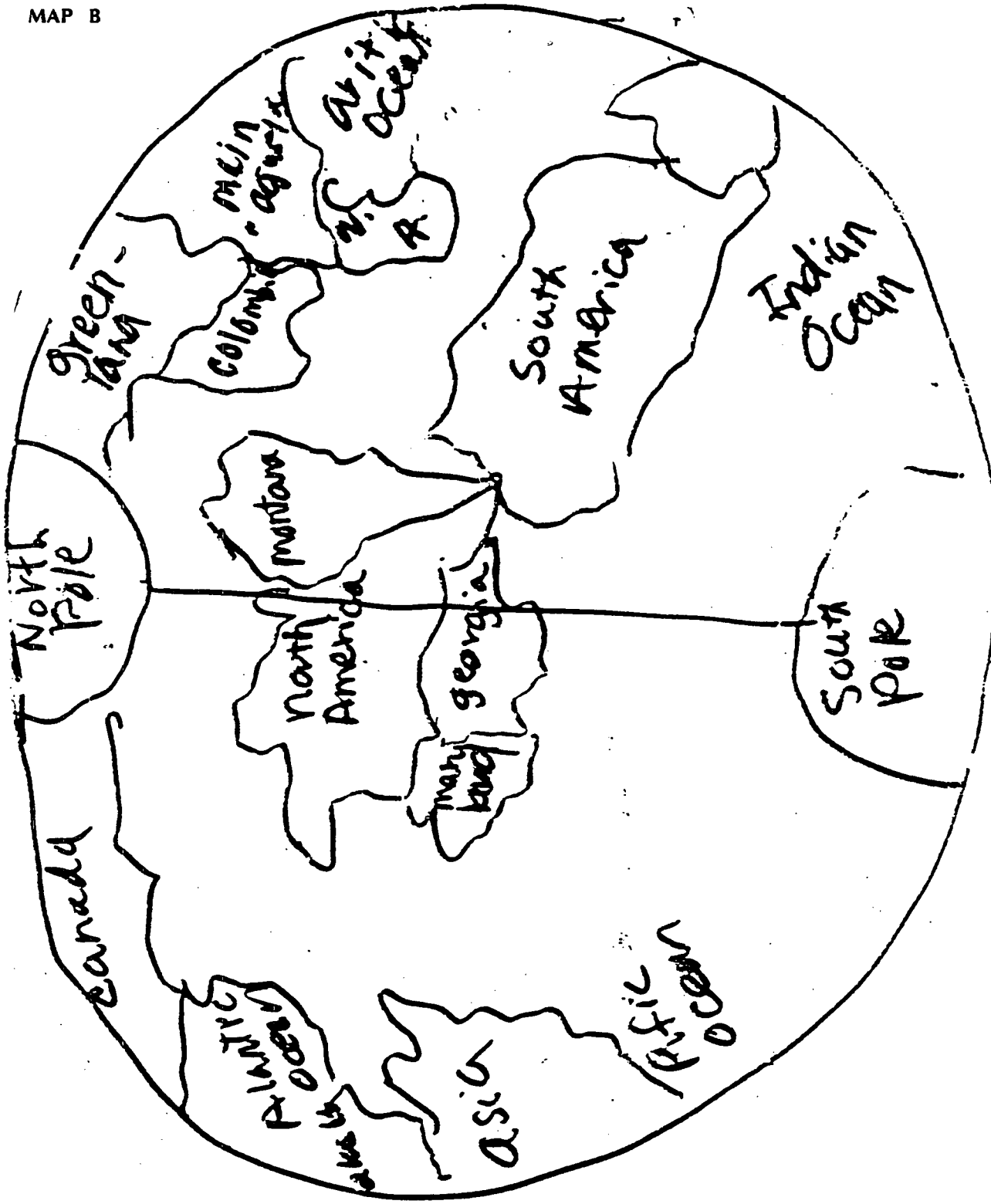
4. How would you proceed to help these students with the problems they are having? What strategies would you use? Why?

SCENARIO #8: INTERMEDIATE (Grades 4-8) - SOCIAL STUDIES
(A. Goran & B. Davis, personal communication, December 1986)

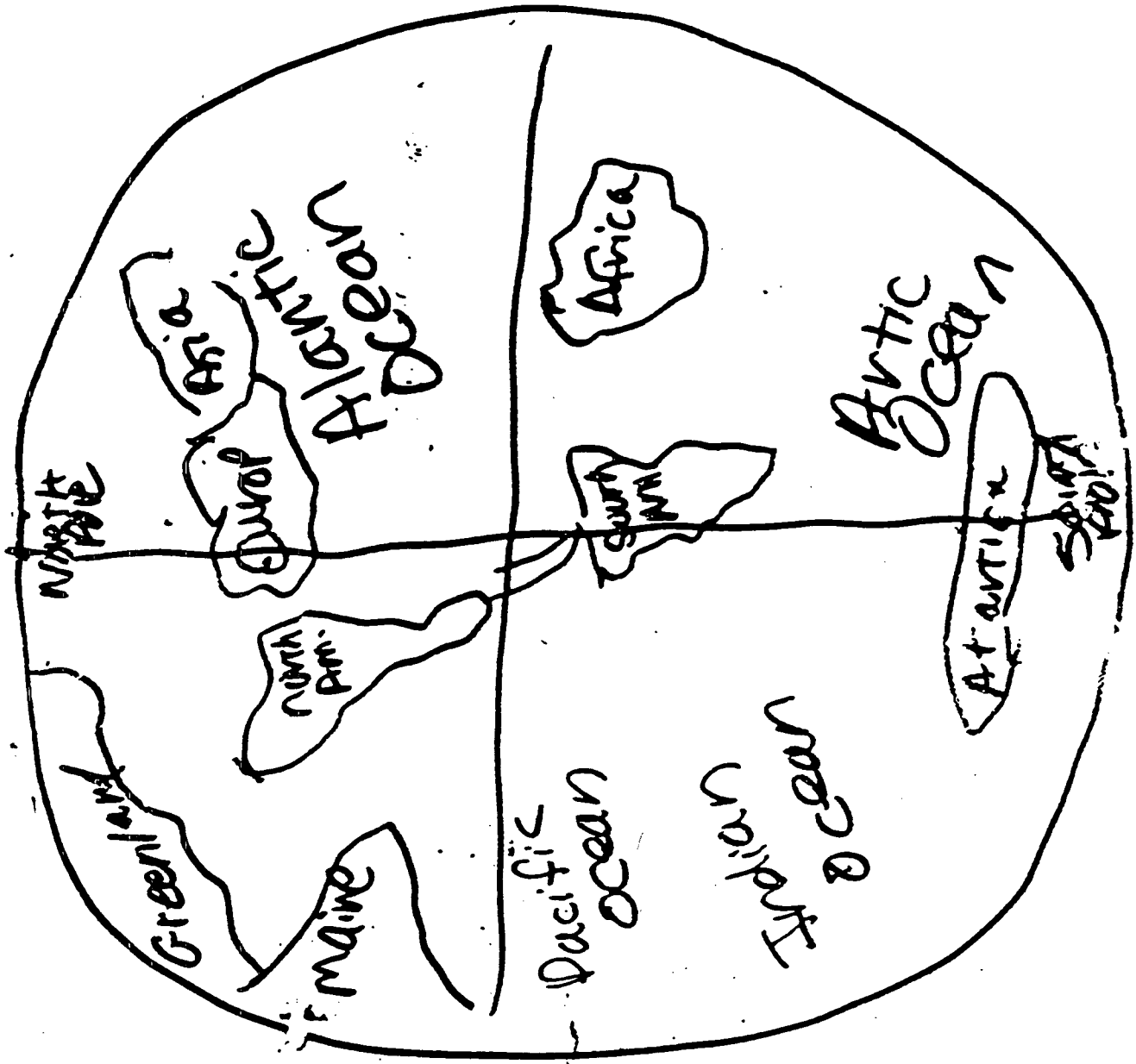
Students in Social Studies classes in a school district in Maine were given a blank sheet of paper and were asked to draw a map of the world. Below are samples of the maps submitted by various students. Please examine the maps carefully and on the answer sheet provided, indicate the grade level of the student that you think each map came from and why you think so:

MAP A

MAP B


Green-
land
Colombia
Main
agent
Atlantic
Ocean
N.C.
A
North
Pole
Montana
North
America
Mary
land
Georgia
South
America
Indian
Ocean
South
Pole
Canada
Atlantic
Ocean
Asia
Pacific
Ocean

MAP C


North Pole
Greenland
Europe
Asia
Atlantic Ocean
Africa
South America
Pacific Ocean
Indian Ocean
Arctic Ocean
Antarctica


Maine
M
New Hampshire
N
Texas
T
d
Africa
ocean
S
Scotland
TO
Tokoyo
Pennsylvania
Me
Germany
Mexico

the worl


Alaska
Can.
Greenland
USSR
USA
Atlantic
Ocean
Moscow
Mex
AF.
So. am.
Asthalian

MAP E

Name: _____

ANSWER SHEET - (INTERMEDIATE/Social Studies)

Please indicate the grade level of the child you think each map came from and why you think so:

Map A

Map B

Map C

Map D

Map E

Imagining that you are the teacher in this situation, please answer the following questions regarding the map drawing task and the grade level(s) you assigned to each: (Feel free to use the back of the page if necessary)

1. What kinds of problems do you think these students are having with this assignment? Why do you think so?

2. What questions do you think these students were asking themselves as they worked through the assignment? Why do you think so?

3. What question(s) would you, as the teacher, ask the students about the problems that you think they are having with the assignment? What responses would you expect to get? Why?

4. How would you proceed to help these students with the problems they are having? What strategies would you use? Why?

APPENDIX B

OTHER VARIABLES OF INTEREST:

Concern for Problem Finding

Demographic Variables

NAME: _____

Please answer the following questions regarding your background and experience(s) as a teacher:

1. Why do you teach?

2. How many years of teaching experience do you have? _____

3. What subject(s) have you taught?

4. What age group(s) have you taught?

5. List any other positions or experiences that you have had that required direct interaction with children and/or adolescents.

6. Why are you participating in this inservice?

7. How familiar are you with Piaget's work and its implications for classroom practice?