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TEACHERS' KNOWLEDGE AND LEARNING TO TEACH

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The question of how teachers learn to teach is clearly basic to the enterprise of teacher education. Only recently, however, have researchers begun to systematically frame and study this question. For the most part, attention in teacher education has traditionally been focused on what teachers need to know and how they can be trained, rather than on what they actually know or how that knowledge is acquired. The perspective, in other words, has been from the outside, external to the teachers who are learning and the processes by which they are educated.

Although the phrase "learning to teach" rolls easily off the tongue, research in this field has, to date, been largely unproductive (see reviews by Feiman-Nemser, 1983; Feiman-Nemser & Floden, 1986; Zeichner, 1987). One suspects that the core problems are conceptual. The phrase itself is not used consistently. Sometimes it refers globally to the entire enterprise of teacher education, or it is a substitute for such constructs as teacher development or teacher socialization. Moreover, the phrase subsumes and sometimes masks key assumptions about (a) *outcomes*, that is, what teachers are or should be learning; (b) *treatments or settings*, that is, what effects can be attributed to programs, program components, or experience in various sites; and (c) *learning*, that is, how change occurs in teaching. As a result, a study focused on the effects of field experiences or student teaching on occupational perspectives and one directed to changes in personal concerns during preservice teacher education are both considered to be about learning to teach, even though the results are not comparable.

Although the manifest purpose of this chapter is to review the state of research on learning to teach, another compilation of discouraging findings was deemed unnecessary and unhelpful. Instead, an attempt was made to construct an intellectual context within which the learning-to-teach process could be framed and understood. To this end, Zeichner (1986, 1987) argues for improved conceptualizations of what goes on in teacher education settings and how individual characteristics interact with these setting features. Although Zeichner's argument is certainly reasonable, it still bypasses issues of the substance of what teachers know or how that knowledge is acquired. In the present chapter, therefore, emphasis is placed on emerging conceptions of teachers' knowledge. In the past, researchers have focused attention primarily on teachers' skills and dispositions. Recently, however, investigators, armed with the new conceptual and methodological tools of cognitive science and interpretive research, have begun to examine the character and substance of teachers' knowledge. Although clearly in its infancy, this line of inquiry is generating lively discussions about theory, research methodology, and teacher education practices. It also seems to be a promising framework, establishing focus and coherence in research on how teachers learn to teach.

To distinguish the chapter from others in this volume, the focus here is primarily on knowledge related to or grounded in classroom practice. The chapter is based, in other words, on a knowledge conception of teaching, and the phrase "learning to teach" is taken to mean the acquisition of knowledge directly related to classroom performance. This definition excludes

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studies specifically focused on teachers' formal subject-matter knowledge (see the chapter by Ball and McDiarmid), teachers' institutional and occupational perspectives (see the chapter by Zeichner and Gore), and the professional knowledge base for teaching (see the chapter by Tom and Valli).

The chapter is directed, then, to questions of what teachers know and how that knowledge is acquired. Three broad categories of teachers' knowledge are examined: (a) teachers' information processing, including decision making and expert–novice studies; (b) teachers' practical knowledge, including personal knowledge and classroom knowledge; and (c) pedagogical content knowledge, that is, the ways teachers understand and represent subject matter to their students. Within each of these categories, implications for conceptualizing research on learning to teach are considered, and specific studies, where available, are reviewed. The chapter opens with an analysis of the assumptions about outcomes, treatments, and learning that are implicit in research on learning to teach. This analysis provides a background for the subsequent review of knowledge domains in teaching. The chapter concludes with an analysis of common themes in this research literature, directions for further inquiry, and implications of this work for designing teacher education practices.

It is important to note that much of the work on teachers' knowledge and learning to teach is in an early, formative stage. As a result, many studies are still in progress, and the emphasis in available reports is as much conceptual as it is empirical. Investigators are in the process of collecting data, often in the form of extensive and detailed case analyses, but the focus at this point is often on the refinement of concepts and method, rather than on the report of findings. This review reflects these characteristics of inquiry in the field.

THE LEARNING-TO-TEACH QUESTION

This section contains a brief survey of research that has been seen to have a bearing on the question of how teachers learn to teach. The purpose of this survey is to clarify the assumptions concerning outcomes, treatments, and learning that have been implicit in this field.

Early Studies of Teachers' Experience

Over the years, investigators have occasionally been interested in the effects of experience on teachers. Within a psychological tradition, there are two major approaches to research on experience. In the first approach, investigators generally focused on the effects of training, feedback, and field experiences on observable behaviors or skills, rather than on knowledge or cognition (see Gliessman, 1984; Peck & Tucker, 1973; Watts, 1987; Waxman & Walberg, 1986). The assumptions were, in other words, that teachers needed to know certain basic teaching skills and that such skills were best learned through directed laboratory practice and extensive practical experience in "real" settings.

Three interesting studies in this area indicate, however, that the effects of training on classroom performance are mediated by cognitive processes and contexts. Wagner (1973) compared a microteaching treatment, in which preservice teachers learned *how* to perform teaching skills, with a second treatment, cognitive-discrimination training. In the latter treatment, the teachers learned *when* skills were appropriate but did not practice them. Wagner found that cognitive-discrimination training had greater effects on classroom performance than microteaching. Along similar lines, Gliessman, Pugh, and Bielat (1979) found that learning teaching skills as concepts, without practice, increased their use in classrooms, and, indeed, the greater the concept mastery, the greater the skill use. Practice without concept acquisition did not affect classroom performance (see Gliessman & Pugh, 1981). Finally, Copeland (1977) found that acquisition of teaching skills in a laboratory setting did not predict their use by student teachers in classrooms. The use of skills was dependent, rather, on the ecology of the classroom in which the student teacher taught. One important dimension of this ecology was prior use of the skills by the cooperating teacher, so that pupils in the classes were familiar with them. As will be seen, these issues of cognition and setting eventually moved to the center of research on teachers' knowledge and learning to teach.

The second cluster of studies is based on personality or development perspectives and focused on attitudes, motives, and concerns. Hoy (1968), for example, examined the effects of teaching experience on pupil-control ideologies and found that, with experience, beginning teachers acquired a more "custodial" attitude toward pupils. Wright and Tuska (1968) devised an elaborate Freudian conception of teacher personality development and utilized the theory to construct semantic differential questionnaires to study the attitudes and recollections of 508 beginning women teachers during student teaching and their first year of experience. They attempted to discover how the resolution of relationships with early authority figures (mother, father, and teacher) influenced the choice of elementary, middle school, or high school careers and shaped their unconscious motives during teacher education. The authors argue that their theory predicted career choices well and explained the personal struggles many candidates experience during preparation. They also found that the women they studied experienced considerable disillusionment as they moved from their "dream" of becoming a teacher to actual teaching during their first year. In contrast with elementary candidates, the women preparing to be high school teachers began to be disillusioned during student teaching. Finally, Fuller (1969) in widely cited research on teacher development, mapped the concerns of teachers, from the early focus on survival and practical techniques to the later emphasis on curriculum and student learning, arguing that these concerns shaped the readiness of teacher education students and practicing teachers to learn about different aspects of teaching.

Research on the occupational and institutional aspects of teaching has concentrated on how teachers are socialized into the norms and perspectives of the profession. Particular attention in this tradition has been given to the familiarity of teaching—prospective teachers have spent a large amount of time as students in classrooms and thus acquire preconceptions

standard classroom practices and solutions to teaching problems—and to the effects of informal contacts between experienced and novice teachers during student teaching and the beginning years of experience (see Dreeben, 1970; Eddy, 1969; Hoy & Woolfolk, 1989; Lortie, 1975; Zeichner, 1986). Familiarity and school-based socialization, it is argued, account for the stability of classroom practices, the conservatism of teachers, and the low impact of teacher education.

Recent Developments

These early studies of teachers' experience have shaped in major ways the current research on learning to teach. Attention to the biographies of teacher candidates, their developing attitudes and concerns, and their professional orientations and perspectives is quite apparent in recent studies in this area. Representative studies are described subsequently to suggest the direction of this influence. Reading these studies, one is encouraged to find that the person in teaching is no longer quietly tucked away in tables of aggregated data. Moreover, these studies represent improvements in the way program effects are described. For example, they put to rest the assumption that programs with the same general goal statements and course guidelines are likely to have similar effects. Rather, they demonstrate that program effects must be described with reference to the actual representation of teacher education content in teacher education classrooms. On the other hand, findings from these studies often appear impoverished, for they tell us little about the actual learning processes of beginning teachers and provide only sketchy information about the substance of the knowledge they acquire.

Entering Dispositions. Work at the National Center for Research on Teacher Education at Michigan State University is focused in part on the levels of disciplinary knowledge in mathematics and writing that prospective teachers possess when they enter teacher education. These researchers use questionnaires with large samples of prospective teachers to determine how respondents understand and would use knowledge of their content in classroom settings and how they view the learner with respect to such content. In addition, extensive interviews are used with smaller samples to uncover respondents' views about common tasks of teaching in these content areas.

Ball (1988), for example, has recently used these methods to explore prospective teachers' understandings of a particular mathematics topic: division with fractions. The questionnaire for this study required respondents to select a story problem that represented a particular division statement from among a limited set of choices. Interviews focused on prospective teachers' backgrounds in learning about the division of fractions and also asked them to discuss their ideas about how they might represent a particular division problem to students. Ball argues that findings from this study were somewhat discouraging, suggesting that the majority of prospective teachers who would be teaching mathematics to both elementary and secondary students had limited knowledge of division with fractions; indeed, most were unable to select the correct representation of the problem posed to them. Interview results helped to explain the phenomenon, suggesting that most prospective teachers' knowledge of mathematics was rule-bound. Few appeared to have a substantive understanding of the underlying principles of this key mathematical concept.

Gomez (1988) asked 90 students enrolled in the first course of their professional sequence to provide written responses to a number of questions directed at obtaining an understanding of prospective teachers' backgrounds in learning writing, at securing information about their reasons for nominations of persons they considered to be good at writing, and the aspects of writing they enjoyed or disliked. The picture that emerged from this study is one of diversity, in terms of both students' backgrounds in learning to write and their stated preferences for different aspects of the composing process. One particularly interesting finding was that most of these teacher candidates held their college coursework in low esteem in terms of helping them increase their ability to write or their knowledge of writing processes in general. Importantly, Gomez concluded from the respondents' comments about good writers that their judgments were based on questionable indices (many had never even seen the writing of those they nominated as good writers) and that their responses suggested that these teachers had limited knowledge about what good writing, in fact, was. Moreover, Gomez interviewed a different set of teachers, in an attempt to ascertain the kind and quality of their responses to an example of student writing provided to them. She found that prospective teachers at both the elementary and secondary level attended mostly to the surface features of the text in the student example, suggesting limited ways that these teachers had of conceptualizing various features of the writing process.

Paine (1988) explored prospective teachers' orientations toward diversity. Using questionnaires and interviews, Paine attempted to analyze respondents' views concerning the meaning of diversity, as well as what their notions of diversity meant when translated to their thoughts about teaching. Paine's analyses led her to conclude that entering candidates' orientations toward diversity were often superficial; their ability to talk about student differences in thoughtful, comprehensive ways was often limited; and their thinking about its pedagogical implications was often quite problematic. For example, these prospective teachers seemed to share the sense that student differences should be taken into account, but they were often unsure about how to think about those differences in terms of planning and arranging academic work. Their discussions of diversity were often contradictory, at one moment uncomplicated conceptually and at another moment quite complicated. For instance, these teachers felt that fairness was the key to successfully attending to student diversity, but their projected mechanisms for dealing with diversity could often be judged to be quite inequitable. One student argued, for example, that all students should be treated the same, but when presented with scenarios of specific differences students might bring with them, she suggested that applying different standards to these students would be appropriate. Paine argues that pretraining teachers' views of diversity are, comparatively, more coherent in the abstract than in the context of specific scenes and situa-

tions, yielding a prepractice view of diversity that is, in large measure, divorced from contexts and concomitantly static.

Amarel and Feiman-Nemser (1988) also used questionnaires and interviews to assess pretraining teachers' views concerning what they needed to know to teach successfully. Students' responses to inquiries around this question indicated that their primary concerns were about management and about feeling at ease in front of students. Moreover, many students simply felt that what they most needed was practical experience in teaching. Students rarely mentioned subject-matter knowledge or enhanced understanding of student learning in their responses and, in general, appeared to devalue what might be learned in professional coursework in advance of their formal study in it. In their study, Amarel and Feiman-Nemser traced closely, in written cases, two pretraining teachers' views of necessary knowledge for teaching to their own remembered school experiences, illustrating how the views articulated by these teachers inhered in their individual experiences as students and as people. Along similar lines, Weinstein (1988) found that candidates prior to student teaching had "unrealistic optimism" about their ability to solve teaching problems in classrooms. They agreed that many experienced teachers had problems in areas of management, discipline, and instruction, but they felt that they would not have these problems. With such an orientation, it is unlikely that these student teachers expected to learn very much from experienced teachers.

Changes in Orientations and Perspectives. Another major focal point for research on learning to teach is the nature of change in orientations, commitments, and perspectives of teacher candidates. Investigators have carefully attempted to unpack orientations through extensive conversations with and observations of candidates. For example, Ball and Noordhoff's (1985) study demonstrated that students' prior dispositions about the use of textbooks were affected, not from a single source, but from several sources, both formal and informal. Ball and Noordhoff followed eight elementary education students in two programs that differed in their structure, ideology, and content. One program, the Academic Program, was characterized by its emphasis on and understanding of disciplinary knowledge and theoretical propositions. The other program, the Decision-making Program, focused on a generically based approach to knowledge of teaching and aimed at improving students' reflective capacities and decision-making skills. Although both programs seemed to convey through coursework a negative view of reliance on the textbook, they differed in the stance toward how to deal with these students, who, during their student teaching and because of various factors (e.g., the cooperating teacher's influence and the lack of other instructional materials) used textbooks heavily. The Decision-making Program continued to suggest strongly the negative aspects of reliance on the textbook, whereas the Academic Program took a more passive approach to this practice. Ball and Noordhoff developed rich cases of two prospective teachers, Danielle and Sarah, to illustrate how programs, persons, and setting affect teachers' orientations to the textbook and, in so doing, suggest that knowledge outcomes from professional preparation are largely characterized by unique features in all three of these aspects.

Hollingsworth (1988) attempted to investigate changes in preservice teachers' knowledge and beliefs before, during, and after a fifth-year teaching program. Hollingsworth developed baseline profiles of 14 elementary and secondary preservice teachers as they entered the teacher education program and, using a constant comparative process involving analysis of interview and observational data, tracked the patterns of their intellectual change over the course of a year. Although the focus was on studying global changes in teachers' knowledge and beliefs, their changing knowledge of reading instruction was also highlighted, in an attempt to relate general knowledge of teaching to content knowledge. By the use of existing taxonomies of cognitive processing and change (e.g., those of Doyle, 1983, and Rumelhart & Norman, 1978), preservice teachers' profiles taken at different points along the year were analyzed for consistency with or deviation from baseline profiles. Patterns emerging from these data led Hollingsworth to develop a model to illustrate that prior beliefs of teachers play a critical part in the process of learning to teach. The model suggests that preprogram beliefs about teaching potentially interact dynamically with program content and classroom opportunities to produce different levels of teaching knowledge. Hollingsworth contends that patterns of knowledge growth suggest a number of themes about the learning-to-teach process:

> *pre-program beliefs* served as filters for processing program content and making sense of classroom contexts; *general managerial routines* had to be in place before *subject specific content and pedagogy* became a focus of attention; and that interrelated managerial and academic routines were needed before teachers could actively focus on *students; learning from academic tasks in classrooms,* while pre-program interest students as individuals and a program-developed interest in subject pedagogy were needed to provide the motivation to do so. In turn, each new level of knowledge affected changes in pre-program beliefs. (p. 9)

Hollingsworth has developed descriptive cases of these teachers that illustrate the movement described in this model.

Zeichner and Tabachnick (1985) followed 13 preservice teachers through their student-teaching experience and a small subset of these teachers into their first year of teaching. Their study attempted to assess preservice teachers' perspectives on the teacher's role, teacher–pupil relationship, student diversity, and knowledge and curriculum. Importantly, student teachers in this study were able to participate in the selection of their field placements. This might have contributed to the finding that little alteration in students' original perspectives in the areas just mentioned was apparent during the practicum. However, individual knowledge "journeys" were observed for the four teachers who were studied during their first year of teaching. Based on their analyses, Zeichner and Tabachnick argue that the knowledge path looks quite different for different individuals and with different contexts for learning. They suggest that there needs to be debate about how to recognize the personal experience of learning to teach and how to promote preparatory experiences that allow individuals to reach their knowledge potential.

Similarly, Feiman-Nemser and Buchmann (1986) were interested in looking at the interactions among classroom setting, professional coursework, and persons on prospective teachers' pedagogical thinking during the student-teaching experience. In terms reminiscent of Fuller (1969), these researchers hoped to track students' movement from daily preoccupations with sustaining pupils' cooperation to thinking about pupils' learning. The two teacher candidates they studied entered the program with limited understandings of teaching. They spent the time and performed the tasks necessary to feel they learned from their student-teaching experience and to get positive evaluations from their cooperating teachers, and yet Feiman-Nemser and Buchmann illustrate in their case studies that neither was able to acquire the kind of pedagogical thinking that they argue is central to teaching, that is, an understanding of how to recognize, evaluate, and implement activities with pupils' learning in mind. Through these case studies, Feiman-Nemser and Buchmann reveal how both coursework in two separate programs and aspects of the settings for student teaching differentially and negatively influenced chances for students' acquisition of critical knowledge of teaching.

Calderhead's (1987) study echoes many of the same themes. The purpose of this study was to determine the kinds of interpretative frameworks student teachers use in their thinking about classroom practice and to study how these frameworks are affected by students' professional development and student-teaching experience. Calderhead found that there were aspects of the student-teaching experience that negatively affected what and how students learned about teaching. Student teachers entered their student-teaching experience with conceptions of teaching that were incomplete and often dysfunctional (e.g., teacher as "guide" and "friend"). But, although their early experiences in student teaching appeared to help them acquire improved knowledge about planning and instructional activities, midway through their student teaching they had reached a plateau in their learning. Interviews with student teachers suggested that they had comparatively more difficulty citing new knowledge or understandings at this point than they had had earlier in their student-teaching experience. Calderhead's analysis of student teaching suggests that, as it often presently exists, it is a sort of "driving test" for students; this experience does not provide for much experimentation, for valid assessment of student teachers' teaching from supervisors, or for student teachers' own chances to reflect and accurately assess their teaching. Here, the themes of the recent research echo the concerns expressed in earlier discussions of the student-teaching experience (see, for example, Griffin, 1986; Richardson-Koehler, 1988; Zimpher, 1987).

Summary and Conclusions

This brief and quite selective survey illustrates well the problems of research on learning to teach. Aside from a few broad generalizations about complexity and multiple interactions, few conclusions can be drawn from these studies. Feiman-Nemser's (1983) appraisal still stands: "With few exceptions, the existing research tells us very little about the actual conduct of teacher preparation . . . [or] about the job of learning" (p. 151). Moreover, there is a distinct lack of coherence across studies. Outcomes are designated in a variety of ways: attitudes, dispositions, orientations, perspectives, knowledge, concerns, or commitments, and, despite apparent differences in meaning, these terms are often used interchangeably. Settings are sometimes only loosely defined and vary widely across studies. Attempts to isolate the relative contributions of program components or experiences (if such isolation is, in fact, an appropriate research goal) are futile under these circumstances. Perhaps most importantly, except for vague references to development, change, and growth, investigators are largely silent about the nature of the learning process in teacher education. Given this conceptual diversity and ambiguity, it is not surprising that cumulative findings are scarce.

One important lesson that can be drawn from this analysis is that the learning-to-teach question might well be unanswerable at a global level. What is needed, instead, are frameworks that focus more explicitly on *what* is learned and that specify more fully how that knowledge is acquired. In an attempt to search for such frameworks, attention in this chapter is directed to recent research on teachers' knowledge.

RESEARCH ON TEACHERS' KNOWLEDGE

The study of teachers' knowledge has emerged only quite recently in educational research. In the behaviorist tradition that dominated the study of teaching and teacher education, knowledge and thinking were generally considered too "mentalistic" for serious research attention, so the focus was primarily on observable behaviors or skills (see Peck & Tucker, 1973). The emergence of systematic research on teachers' knowledge and its acquisition signaled a substantial shift from a preoccupation with behavior and with what teachers need to do to a concern with what teachers know and how that knowledge is acquired through formal training and classroom experience.

The emphasis on cognition in teaching was stimulated, in large measure, by the growing concern for cognition and context in the social sciences and by the appearance in the late 1960s of qualitative or interpretive studies of classroom teaching. By generating richly detailed portraits of the demands of classroom environments and the ways in which teachers struggled to cope with these demands, this tradition had a powerful influence on the development of research on teachers' knowledge and its acquisition. As the study of cognition became more widely acceptable in the social and behavioral sciences, educational researchers turned to the study of teachers' cognitive processes and thinking (see Shavelson, 1983).

In one of the seminal qualitative studies, Jackson (1968) describes life in elementary classrooms in evocative detail. As part of this study, he interviewed 50 elementary teachers nominated by their administrators as outstanding and examined the ways in which they talked about their work. The interviews focused on the teachers' self-evaluations, their conceptions of institutional authority-relationships, and the satisfactions they derived from their work. Jackson identified four recurrent themes in the interviews: immediacy, informality, autonomy,

and individuality. The teachers reported that they watched for immediate and spontaneous signs of involvement and enthusiasm to tell how things were going. Formal tests of students' achievement, on the other hand, were distrusted, because the teachers felt that pupil performance was atypical on tests and that the tests measured native ability rather than teaching effectiveness. The teachers also described their style of interacting with students as informal, within the limits of institutional responsibility and authority. Autonomy, they felt, was threatened by curricular constraints and by administrators' intrusions for evaluation, both of which reduce spontaneity and insult professional pride. Finally, seeing an individual child make progress, especially one who was unresponsive or unlikely to succeed, was their greatest source of satisfaction or joy in teaching.

In one of the more controversial parts of this analysis, Jackson (1968) characterizes the teachers' language and thought as conceptually simple and lacking in technical vocabulary. Caught up with the here and now and in emotional ties with pupils, they had, he argued, a simple and uncomplicated view of causality, they adopted an intuitive rather than a rational approach to classroom events, they were quite opinionated about their classroom practices, and they had narrow working definitions of abstract terms (e.g., motivation and intellectual development). His assessment of these characteristics was quite mixed. He deplored the particularity, impulsivity, conservatism, and myopia of their talk and their technical naivete, in comparison with psychologists.

Jackson was not the first to use psychologists as the standard for judging the adequacy of teachers' knowledge. In a widely cited classic, Wickman (1928) reports substantial differences between the attitudes of teachers and those of mental health experts concerning the significance of children's behavior. Teachers tended to rank disruptive behavior, violations of rules, and sexual transgressions as the most serious behavior problems; clinicians, on the other hand, saw passivity and withdrawal as more serious than acting out. Jackson also acknowledges that what teachers knew was perhaps appropriate to the complexity and unpredictability of the settings in which they worked. He speculates that a rational and deliberative style might be more prevalent in the "preactive" phase of teaching, during which teachers planned for teaching, rather than in the "interactive" phase, in which teachers faced the uncertainty and confusion of classroom events.

A similar emphasis on knowledge was evident in Smith's microethnographic study of a seventh-grade teacher in an urban classroom (see Smith & Geoffrey, 1968). Smith carefully describes how Geoffrey established classroom procedures and routines, built relationships with students, orchestrated classroom activities, and conducted lessons. With Geoffrey's help, Smith also mapped the working theories that accounted for these teaching actions.

Finally, Kounin (1970) published the results of an extraordinary research program directed at fundamental questions in classroom management and discipline. Kounin began his work on the practical problems of classroom discipline by focusing on "desists" (what teachers do to stop misbehavior after it occurs) and "ripple effects" (how desists affect nontarget students in the class). After only modest success in accounting for students' work involvement, Kounin turned to an ecological analysis of over 250 videotaped lessons to learn how teachers managed classroom groups. He found that four clusters of actions—withitness, overlapping, group focus, and movement management—were associated with high levels of work involvement. Kounin's clusters clearly imply cognitive processes, that is, awareness and divided attention.

These early qualitative studies underscored the cognitive dimensions of teaching practice and made specific contributions to subsequent work on teachers' thinking and knowledge. Jackson's distinction between preactive and interactive thinking shaped research on teachers' decision making, and his emphasis on teacher's naive knowledge, along with Smith and Geoffrey's ideas of working theories, stimulated research on teachers' implicit understandings of teaching. Finally, Kounin's cognitive-related formulations of classroom management, as well as his ecological approach to inquiry, had a direct bearing on conceptions of teachers' classroom knowledge.

Within the broad field of research on teachers' knowledge, several distinct but overlapping approaches have evolved, approaches that represent different assumptions, emphases, theoretical frameworks, and methodological commitments and yet share many common themes. For purposes of this review, three approaches have been identified: (a) information-processing studies, which have tended to focus on decision making and contrasts between experts and novices; (b) studies of teachers' practical knowledge, or what teachers know about actual practice and the navigation of complex classroom settings; and (c) studies of pedagogical content knowledge, or what teachers know about subject matter and its representation to students.

Information-processing studies are typically framed in the technical language of psychology and often use controlled laboratory settings and/or standardized tasks and data collection procedures. The focus in such studies is typically on the cognitive processes or operations teachers use in thinking about teaching. Research on practical knowledge includes studies of teachers' personal knowledge and implicit theories, as well as ecological studies of the demands of classroom environments and their effects on the thoughts and actions of participants. Personal knowledge studies are typically grounded in a phenomenological perspective, use qualitative or interpretive methods consisting of extensive observations and interviews of one or a few teachers, and express findings in a language that reflects the expressions of the teachers who were participants in the research. The emphasis in these studies is often on idiosyncratic perspectives, interpretations, intentions, or beliefs that influence the sense teachers make of classroom situations. Ecological studies also rely on qualitative methods but focus on how thought and action are organized by situational tasks. Thus, formal, analytic descriptions of environmental structures are considered useful approximations of what participants know and how they comprehend actions and events. Finally, studies of pedagogical content knowledge employ information processing and qualitative methods to construct cases but focus on subject matter and the structure of explanations as key features of teachers' knowledge.

In the following sections, each of these frameworks is described, and implications for the formulation of research on learning to teach are delineated. Where possible, studies of learning to teach that relate to a framework are reviewed.

Information Processing

Information-processing approaches to teachers' knowledge have as their focus operations inside the minds of teachers, that is, the mental processes teachers use to identify problems, attend to cues in the classroom environment, formulate plans, make decisions, and evaluate alternative courses of action. Early studies on teacher planning and decision making were based largely on psychological frameworks and often used decision-tree structures to model processes in teachers' minds. The goal of the research was to determine the points and parameters of teachers' choices about their actions. Later, studies of expert and novice differences in teaching emerged, studies that attempted to unravel in a more complex fashion what was in the minds of different teachers as they taught. These studies were still focused primarily on internal processes, but some investigators attempted to focus on common pedagogical problems derived from classroom settings, as opposed to more artificially constructed laboratory tasks. These two related, but distinct, areas are summarized next.

Teacher Planning and Decision Making. Beginning in the 1970s, considerable interest was devoted to the study of teachers' planning and decision making, using a variety of interview, think-aloud, and observational strategies. This literature has been extensively reviewed by Clark and Peterson (1986) and will only be summarized briefly here.

Following Jackson's (1968) distinction cited earlier, decision-making research is divided between preactive or planning studies and interactive studies. For a time, greater attention was given to planning than to interactive thinking. This occurred partly because of the immediate interest in knowledge use and decision-making processes and partly because methods for engaging in studies of planning were comparatively more available and accommodating. Much of the planning research focused on the types of teacher planning (yearly, unit, weekly, daily), the topics around which planning occurred (objectives, activities, content, students), the cognitive processes teachers used in planning (forming mental images, problem finding and formulation), and the effect of planning on classroom performance.

Research on interactive decision making, which was much less common, tended to focus on the topics around which decisions were made (learners, classroom management, instruction), the frequency of decisions, and the effectiveness of different patterns of decision making. The primary research tool for interactive studies was the stimulated-recall interview, in which teachers viewed a videotape of their teaching and were asked to tell what they were thinking about during the lesson. This method has been strongly criticized recently on grounds that it generates accounts of the videotaped segment rather than an accurate report of what the teacher was thinking about at the time of the original event (see Ericsson & Simon, 1980; Yinger, 1986).

One of the major conclusions from this research tradition was that prior assumptions about teachers' decision making were often inaccurate. Investigators found, for instance, that teachers seldom followed formal Tylerian models of planning and that, during interaction, teachers seldom made logical choices among several different alternatives. Rather, their actions seemed to be largely governed by rules and routines, with decision making in a studied, deliberative sense taking a minor role in their interactive thinking.

Some attempts have been made to examine planning and interactive teaching in a learning-to-teach framework. For example, Borko, Lalik, and Tomchin (1987) and Borko, Livingston, McCaleb, and Mauro (1988) explored novice teachers' thoughts about planning and specific instructional events. The investigators followed students through the final year of professional preparation and the first year of teaching. Through interviews, analyses of journals, on-site observations, and videotaped records of teaching, contrasts were made between weaker and stronger student teachers in terms of their developing understandings about instruction and planning. Both strong and weak student teachers had similar initial conceptions of successful lessons, views that did not appear to become markedly different over the year-long field experience. However, their views about unsuccessful lessons and about planning did differ over time. Moreover, stronger teachers apparently came to engage in comparatively more complex planning activities than did weaker novices. They planned in more detail, anticipated events that might affect their written plans, and developed solution strategies to deal with such problems. Rohrkemper's (in press) work suggests a plausible explanation for differences in teachers' development of teaching knowledge. It could be that teachers who developed richer and more efficient understandings about teaching learned well from unsuccessful lessons and failure situations.

Expert–Novice Studies. Beginning in the mid-1980s, information-processing researchers turned their attention to studies designed to account for differences in thinking between expert teachers and candidates in initial teacher-preparation programs. The study of expert–novice contrasts in teaching drew upon a relatively new, but well established, body of work in cognitive psychology on expert–novice differences (see Chi, Claser, & Farr, in press).

Carter, Sabers, Cushing, Pinnegar, and Berliner (1987), using a simulated teaching task that required subjects to prepare to take over a class in midyear, examined expert–novice differences in processing and using information about students. One major finding from this study was that the routines that experts reported for organizing and managing instruction were comparatively more rich than those of novices. Protocols obtained in the study suggested that experts, when preparing to assume responsibility for a class that had been previously taught by another teacher, gave considerable attention to getting the students "to work." Experts were anxious to "start fresh" with the class and to organize the group of students so that they could move through the curriculum. In coming to understand what

needed to be done, experts were also able to make clear inferences about the previous teacher's practices. Much of this expert thinking was guided by routines and action plans drawn from their prior experience in the classroom. Novices were much less specific in interpreting what the previous teacher had done and in describing changes they might want to make in class routines and assignments.

In a task designed to uncover expert and novice differences in visual information processing, Carter, Cushing, Sabers, Stein, and Berliner (1988) discovered a related focus on classroom work systems. Indeed, "work" appeared to be a salient organizing concept for experts as they viewed a series of classroom slides presented to them. Their comments suggested that they saw classrooms as moving systems and that they reacted quickly to visual stimuli indicating whether or not students were "working" well within that system. Novices' protocols did not reveal the same level of attention to work-related actions of students but rather described the physical appearance of the students.

In this study, experts also showed a sense of "typicality" about classroom scenes and individual students' behavior. Once experts assessed a situation as typical, they had little more to say. If situations or behaviors depicted in the slides appeared to be unusual, however, experts spent considerable time attempting to make sense of anomalies. It appears, then, that experts' responses to management-related visual stimuli in classrooms are driven, at least in part, by their perceptions of what is typical, versus atypical, in classroom scenes. As might be expected, this sense of typicality was notably rare in novice protocols.

In another study designed to examine expert–novice differences in teaching, Housner and Griffey (1985) found that expert physical education teachers constructed elaborate managerial plans for implementing activities and tasks for their students. Novices, in contrast, planned logically well-formed activities for teaching motor skills or exercise routines, but they gave considerably less attention than experts to how these events would be carried out under classroom conditions.

Peterson and Comeaux's (1987) study of experienced and novice secondary social studies teachers sought to explore differences in teachers' recall, representation, and analysis of classroom problem situations. In this study, teachers were shown videotapes of three different 4-minute scenes in social studies classrooms. One scene portrayed an episode in which a teacher was handing back essay tests students had previously taken. In this scene, a number of related interactions and events occurred (e.g., students complained about grades and the teacher chided students for their lack of effort). The second videotaped scene portrayed a classroom discussion about the Civil War (within which a number of distracting student behaviors occurred and teacher attempts to desist such behaviors took place). The third and final classroom episode revolved around students cheating on a test and the simultaneous instances that occur when the teacher attempts to discuss the infraction with students. Each of these scenes contained 17 actions, either verbal or physical, that were notable and of nearly the same duration.

Participants in this study were initially shown one of these three videotaped scenes and asked to recall as many events as they could after this initial viewing. The videotape was then shown again to participants, but this time they were asked to discuss points at which the teacher might have made a different decision that would have positively affected subsequent occurrences and to describe alternative decisions to the ones the videotaped teacher made at those points. This pattern of viewing and questioning was repeated for each of the three videotaped episodes.

Participants were given recall scores, based on the number of events they remembered from the first viewing of the videotape. In addition, their discussions about alternative decisions were rated for the level of knowledge that seemed to characterize their responses. Responses were coded as *Level 1* if they appeared to focus on surface or literal characteristics of classroom events and *Level 2* if they suggested knowledge of underlying principles and procedures for managerial or instructional tasks. Results from these analyses suggested that experienced teachers had significantly greater recall of classroom events than did novice teachers. Moreover, experienced teachers' discussions of alternate decisions and their potential impact on the course of classroom events suggested that they had richer knowledge of the underlying structures or meaning of teaching and learning events. Peterson and Comeaux argue that it is probably these comparatively more complex understandings that assist experienced teachers in accurately perceiving and appropriately responding to interactive teaching events.

Ropo (1987) used a combination of interviews and observations to examine the differences in three expert and four novice mathematics teachers. Ropo focused on teachers' conceptions of interaction in the classroom and on the nature of interactions observed for these teachers during the last 2 months of the school year. Analysis of both the interview and observational data suggested that one salient difference between expert and novice teachers was their knowledge of students and the impact of that knowledge on the form and substance of their interactions. In comparison with novices, experts focused more on concrete examples of interactions to bring about student learning and on the importance of analyzing students' responses to the work, in order to plan future instructional interactions and actions. In addition, experts discussed the need, and exhibited the ability to change the plan for the lesson, dependent on contextual and situational factors.

Borko and Livingston (in press) also examined expert and novice differences in mathematics teachers. Specifically, they explored differences in expert and novice teachers' planning, teaching, and postlesson reflections. Using interviews and observations, these researchers uncovered a number of differences in teachers' planning and enactment of mathematics instruction. Not surprisingly, they found that the planning of novices was comparatively less efficient than that of experts and that the enactment of lessons was comparatively more problematic for novices when unexpected events obstructed the scripted actions they had for their instruction. Moreover, novices' postlesson reflections ranged across a wider host of concerns than experts' and were noticeably more dependent upon the events of the day. Borko and Livingston explain these differences in terms of experts' more complex, connected, and

easily accessed schemata for classroom events and upon their concomitant abilities to use these schema to improvise in the face of surprising circumstances.

In summary, these studies suggest that expert teachers, in contrast with novices, draw on richly elaborated knowledge structures derived from classroom experience to understand teaching tasks and interpret classroom events. Expert teachers know the common forms of activities (recitations, seatwork, discussions) and academic assignments as classroom occurrences. They are familiar with typical behaviors, interactions, and situations associated with such events. This event-structured knowledge appears to help experts make highly accurate predictions about what might happen in a classroom.

Contributions of Information-Processing Studies. L. Shulman (1986) notes that research on teacher planning and decision making, by focusing on a few characteristics of teachers' thinking, has closely resembled process–product research in its search for predictors of teaching effectiveness. Given this framework, investigators have typically examined a narrow range of topics that teachers might be required to think about. Other than calling attention to the types and frequencies of teachers' thoughts or decisions, then, information concerning teachers' knowledge or learning remains sparse. The focus, in other words, has been on cognitive processes, rather than on the knowledge teachers use to interpret situations or formulate plans and decisions.

In many respects, a similar criticism can be made of research on contrasts between experts and novices. These studies have tended to focus on a few topics about which teachers think and on the character or quality (e.g., efficiency or accuracy) of their thinking. And some investigators have been tempted at times to revert to process–product formulations and, thus, treat these characteristics of experts' thinking as criteria for judging teaching effectiveness. This level of generality is a potential hazard in the design of expert–novice studies. Any attempt to account for differences between novices and experts is likely to lead only to broad generalizations about the quality of those differences. But simply knowing that there are qualitative differences between novices and experts is not especially helpful in understanding what teachers know. Moreover, without actually tracing the processes by which novices become experts, nothing is learned about how experts' knowledge is acquired.

At the same time, expert–novice studies have provided a useful framework for beginning to examine teachers' knowledge and the path to expertise. There are, in fact, three important implications for teachers' knowledge that can be drawn from the teaching studies and other studies in semantically rich domains such as medical diagnosis (Patel, Frederiksen, & Groen, 1984); political cognition (Fiske, Kinder, & Larter, 1983); physics problem solving (Champagne, Gunstone, & Klopfer, 1983; Chi & Glaser, 1982, Larking, McDermott, Simon, & Simon, 1980); and games such as chess or bridge (Chase & Simon, 1973; Engle & Bukstel, 1978). *First*, experts' knowledge is *specialized and domain specific*. Experts are not simply more efficient in general problem-solving skills (e.g., problem analysis and hypothesis formulation and testing). Expertise appears, rather, to be based on highly specialized knowledge in a particular domain. Expert teachers have richly elaborated knowledge about classroom patterns, curriculum, and students that enables them to rapidly apply what they know to specific cases. *Second*, experts' knowledge is *organized*. Their stored knowledge of scenes, patterns, and procedures is organized around interpretative concepts and propositions that reflect the task environments in which they operate. Novices, on the other hand, often focus on discrete objects or surface features of events and problems. *Finally*, much of what experts know is *tacit* knowledge. Such knowledge does not readily lend itself to formalization and direct instruction, but rather it is constructed or invented from repeated experience accomplishing tasks in a domain (Simon, 1979). As a result, it takes considerable time to become an expert. Simply telling novices what experts know will not produce expertise.

These features of expertise suggest the need for better conceptions of the substance and organization of teachers domain-specific knowledge and the processes by which that knowledge is acquired. Without these conceptions, the path from novice to expert is difficult to trace or guide. The focus, in other words, must be on what experts know and not just what distinguishes them from novices. Moreover, as Clift (1989) notes, it is insufficient simply to attribute differences to experience, without a conception of how expertise is acquired from experience. Finally, present conceptions of teaching knowledge might wrongly imply that expertise in teaching is acquired through repeated, successful experiences, and it might fail to take into account growth that occurs through experiencing, and learning from, failure (see Rohrkemper, in press, for a more comprehensive discussion of this view). The following reviews of teachers' practical and pedagogical content knowledge represent important movements toward better understandings of knowledge and learning in teaching.

Practical Knowledge

Studies framed in the information-processing tradition, by opening up inquiry into cognition in teaching, were important precursors to research on teachers' knowledge. Subsequent research has focused more specifically on the substance and organization of that knowledge. For present purposes, the research on the domain-specific knowledge of teachers is divided into two broad categories: practical knowledge and pedagogical-content knowledge.

In this section, research on teachers' practical knowledge is reviewed. Practical knowledge refers broadly to the knowledge teachers have of classroom situations and the practical dilemmas they face in carrying out purposeful action in these settings. Included in this review are studies of teachers' personal practical knowledge and implicit theories, ecological studies of classroom knowledge structures and comprehension processes, and emerging theories of how teachers use knowledge to plan and carry out instruction. In contrast with the more deliberative focus of the previously discussed studies of planning and information processing, the emphasis in the study of classroom knowledge is clearly on the complexities of interactive teaching and thinking-in-action.

Personal Practical Knowledge. As the label implies, research on teachers' personal practical knowledge focuses on the personal understandings teachers have of the practical circumstances in which they work (see Feiman-Nemser & Floden, 1986). Investigators in this area argue that practical rationality is fundamentally different from the technical rationality that dominates academic conceptions of professional knowledge (see Schön, 1983). Under technical rationality, research leads to generalizations about the nature of things, and practitioners are to apply this objective, scientific knowledge to solve problems and achieve effective outcomes. But the realities of practice are quite different. Professionals make complicated interpretations and decisions under conditions of inherent uncertainty (Doyle, 1986), and to do this they engage in practical thinking that leads to an action appropriate to the particular situation. The knowledge required for practice under these circumstances is experiential, that is, it evolves out of "reflection-in-action" (Schön, 1983) as professionals deal with the complexity and uncertainty. Moreover, practical knowledge is shaped by a professional's personal history, which includes intentions and purposes, as well as the cumulative effects of life experience. Such knowledge must be expressed, therefore, in all of its rich particulars and in a language close to that of the practitioners themselves.

Investigators in this area argue further that conventional research on teaching is based on technical rationality and ignores the practical knowledge and personal intentions of teachers. Such conventional research has, therefore, limited utility for practice and imposition of findings from such research deskills teachers (see, for example, Richardson, 1989; Schwille & Melnick, 1987; Woods, 1987). From the perspective of practical rationality, the knowledge base for teaching resides as much within the ranks of teachers as it does in outside, research-derived principles for practice (Elbaz, 1987). Some scholars, arguing from a feminist perspective, suggest, in fact, that prevailing conceptions of what professional knowledge is have often silenced the voices of teachers and prevented professional growth (Richert, 1987). As Atwell (1988) suggests, "life in schools for teachers and students is too often a performance of either cheery or grudging subordination of the ego to a positivistic, idealist world of science or the arts" (p. 4).

Although there are often substantial differences across research programs, studies of personal practical knowledge have generally consisted of intensive case analysis, and in some instances self-analyses, of classroom episodes. By staying very close to the action of classrooms, investigators have tended to focus inquiry on the images, metaphors, and tacit theories teachers use to make sense of specific events in classrooms. The following review of the major research programs illustrates the general properties of inquiry in this area.

Implicit theories. Some investigators, in early studies of planning and decision making, attempted to account for the decisions teachers were making by constructing, often in close conjunction with them, implicit theories, that is, conceptions of the personal values, beliefs, and principles that seemed to guide action. Janesick (1977), for example, concluded that the sixth-grade teacher she studied intensively was primarily committed to creating and sustaining a stable and cohesive classroom group. Marland (1977) derived five principles of practice from stimulated-recall interview transcripts of six elementary teachers: compensation (favoring shy, low-achieving, or impoverished students); strategic leniency (ignoring infractions by students who needed special help); power sharing (attempting to use peer power to influence the group); progressive checking (inspecting and helping during seatwork); suppressing emotions (avoiding expressions of their own emotions, so as not to excite students and create management problems).

Elbaz. Through a case study of a high school English teacher called Sarah, Elbaz (1983) attempted to define the character of practical knowledge in teaching. She identified five broad domains of practical knowledge: (a) self, (b) the milieu of teaching, (c) subject matter, (d) curriculum development, and (e) instruction. She also identified three levels of generality in the organization of practical knowledge. The first level consists of *rules of practice,* which are statements of what actions to take in particular situations when purposes are clear. The second level consists of *practical principles,* which are broader statements for use in reflecting upon situations and selecting from among practices those which apply to specific circumstances. The third level consists of *images,* which are general orienting frameworks. "The teacher's feeling, values, needs, and beliefs combine as she forms images of how teaching should be, and marshals experience, theoretical knowledge, and school folklore to give substance to these images" (Elbaz, 1983, p. 134).

Elbaz's study provides insights into the overall scope and organization of teachers' knowledge and the connection of that knowledge to practical conditions of teaching. At the same time, the focus tends to be on the characteristics, rather than the substance, of what teachers know.

Lampert. In case analyses of two elementary teachers and of her own teaching, Lampert (1985) examined the personal knowledge teachers use to manage dilemmas in teaching. The emphasis in these analysis was on how knowledge of self, especially of personal values and intentions, and knowledge of students was used to handle competing goals such as the desire to work with an individual student and the need to deal with groups of students. Lampert's work gives a useful perspective on the choices teachers face in classrooms and the personal meaning these choices have.

Munby and Russell. Munby and Russell have grounded their work in Schön's (1983) explication of the epistemology of practice, especially the notions of nonpropositional knowledge (i.e., knowledge that is not easily expressed in rules, maxims, or prescriptive principles), reflection-in-action, and the effects of problems and surprises on the development of professional understandings (see Munby, 1986, 1987, 1989; Russell, 1989; Russell & Johnston, 1988; Russell, Munby, Spafford, & Johnston, 1988). In working closely with a sample of preservice, beginning, and experienced teachers, they have concentrated especially on the metaphors in teachers' accounts of their practical knowledge about instruction and curriculum and on the changes across time that occur in these metaphors. They argue that the study of teachers' metaphors could be a powerful way of uncovering how teachers frame and solve classroom problems. Further, these authors suggest that metaphors might

provide a window into the levels and types of professional knowledge held by different teachers.

Russell and Johnston's (1988) case studies of four teachers illustrate the kind of work that these authors do to explore teachers' professional knowledge. The focus of the analysis was on the extent to which these four teachers reframed the events of practice and acted on their new understandings in subsequent teaching events. Moreover, they examined how these teachers' images of teaching constrained or unlocked possibilities for teachers to learn from their experiences in teaching. For example, the teacher who appeared to be constrained the most by her image of teaching and learned the least from her experience was Wendy, a high school science teacher who saw herself as a transmitter of knowledge. During her first 2 years of teaching, she came to explore methods of helping students participate more fully in classroom work, but she was not able to reframe her experience in ways that resulted in notable changes in her teaching actions. She did modify and improve a number of her teaching techniques, but her teaching stayed largely consistent with the transmitter view, despite her expressed wish to change. Russell and Johnston argue that Wendy appeared to view teaching through a "conduit" metaphor, a metaphor that describes her prevailing view of teaching as carrying students through the curriculum.

In contrast, Roger, a fifth-year science teacher of seventh and eighth grades, came to teaching with a strongly held belief in the inquiry approach, but he learned from watching his students that, although they enjoyed working with science in this fashion, their *learning* of the content and concepts of science was sometimes questionable. Roger began to read criticisms of the inquiry approach to teaching that he had supported, but he initially greeted these criticisms with anger and resentment. Later he experimented by using his own blend of inquiry and content knowledge in science, and, seeing that his students were constructing much-improved meaning about the subject of science, he altered his original view of teaching and continued to construct his own interpretation of teaching from his classroom experiences and from his reading of theory about how children learn. Russell and Johnston illustrate how Roger's metaphors for teaching revolved around students and their understandings of science and conveyed a view of teaching that was focused on attending to how students learn from the activities that he enacted with them in classrooms.

In their studies of professional knowledge, these investigators have been especially sensitive to patterns of development in teachers' awareness of practice events. Initially, teachers become aware of the strategies with which they are comfortable. With more experience, they fine-tune these strategies. The researchers argue that, at these two levels, teachers strive to maintain a coherent framework and tend to ignore back talk from their classes. At the next level of awareness, teachers become attentive to students' reactions, reflect on puzzling situations, and start to reframe their view of their practice. They now begin, in other words, reflection-in-action, a process through which practice changes, although teachers might not always be able to express their reframed view analytically.

Clandinin and Connelly. The work of Clandinin and Connelly is, in many ways, the most clearly personalistic in this tradition (see Clandinin, 1985; Clandinin & Connelly, 1986; Connelly & Clandinin, 1985, 1986). These investigators concentrate on specific teaching episodes in a teacher's classroom and on the personal practical knowledge defined as an account of how the teacher knows this situation. They reject Schön's (1983) focus on problems in favor of an emphasis on regularities and patterns, that is, practical rules and principles, routines, rituals, habits, cycles, rhythms, and images. Image is especially important as a type of knowledge that "draws both the past and the future into a personally meaningful nexus of experience focused on the immediate situation that called it forth" (Connelly & Clandinin, 1985, p. 198).

These investigators further reject Schön's conceptual understanding of teachers' thinking in favor of an experiential understanding found in the narrative unities of practitioners:

> Narrative unity is a continuum within a person's experience which renders life experiences meaningful through the unity they achieve for the person. What we mean by unity is a union in a particular person in a particular time and place of all that has been and undergone in the past and in the past of the tradition which help to shape him. (Connelly & Clandinin, 1985, p. 198)

From the perspective of method, a study in this research program involves the preparation of narrative accounts of field notes and interviews. The narrative accounts are the first formal step in the interpretive process. They are written in the first person and are addressed as letters from the researcher to the teacher as a way of initiating discussion of developing notions of the teacher's personal practical thinking. The interaction enables a researcher to uncover a teacher's personal philosophy of teaching, as well as the historical, personal and professional experience that allows the teacher to reconstruct narrative unities.

These researchers used fragments of teaching episodes as a basis for working with the teacher to uncover the narrative unity. In one case study (Kroma, 1983), for example, these teaching episodes included a note-taking activity in science in which scientific terms were to be recorded verbatim, a discussion of botany in which the teacher downplayed technical language, and the teacher's use of slang when he was holding a snake and preparing to show a biology film. Through narrative method, these seemingly unconnected fragments of teaching were woven together through a researcher and teacher's dialogue in ways that revealed the teacher's reasonably coherent set of practical understandings. This dialogue suggested that this teacher placed importance on having students confronted with various forms of language in the classroom and on ultimately being asked to improve their use of standard language. In this method, teaching episodes are not easily "horribilized" by outsiders, because the episodes are connected to a teacher's understanding of how the curriculum interacts with such things as the constraints and cycles of the school year and to an overall instructional plan.

In recent studies, Clandinin (n.d.) has begun to focus on novice teachers' personal experiences in classroom settings and the impact of that experience on how they understand their work. For example, Clandinin describes the case of Stewart, a

beginning kindergarten teacher who cared greatly about relating to children and spending time interacting with them individually. As Stewart's first year of teaching progressed, the tensions between his desires to spend quality time interacting with students about academic matters and the stops, starts, and surprises of the school calendar surfaced in ways that caused him, over time, to gain a rhythmic sense of teaching. Reconstructing knowledge about classrooms was quite uncomfortable for Stewart at first, but by the spring of the year, he had come to understand the school cycle, so that he could operate within the demands of his particular workplace. On the basis of this case study, Clandinin argues that the acquisition of teaching knowledge is not adequately portrayed as the obtaining and practicing of a set of skills. Instead, "Learning to teach involves the narrative reconstruction of a teacher's experience as personal practical knowledge is shaped through its expression in practical situations" (p. 22).

Summary. Research on teachers' personal knowledge, by focusing primarily on idiosyncratic forms and expressions of knowing and acting, tells more about the characteristics of teachers' knowledge than about what teachers know. The results of this inquiry do not add up to a codified body of teaching knowledge. Indeed, some investigators (e.g., Clandinin and Connelly) explicitly reject this level of general conceptual understanding in favor of an experiential understanding of teaching that does not separate knowledge from the knower. By staying very close to the particulars of practice, however, this tradition does provide a rich picture of the effects of experience and the conditions under which teachers use their knowledge to make sense of a complex, ill-structured, classroom world of competing goals and actions. It furnishes, in other words, a theory of how teachers learn by teaching and how teachers use their knowledge, rather than a generalized conception of what teachers know.

In many respects, this personalized view of teachers' knowledge is implicit in much of the research on learning to teach, especially that which has focused on such outcomes as attitudes, beliefs, orientations, and perspectives (e.g., Zeichner, 1987). In these studies it is assumed, in other words, that knowledge at the level of classroom practice is, at the core, personal and idiosyncratic. The issue then becomes one of how settings affect the development of personal perspectives, rather than of how teachers learn a defined body of knowledge about practice.

This personal conception of practical knowledge is not, however, the only way of describing what experienced teachers know about teaching. In the next section, one alternative, research on classroom knowledge, is considered.

Classroom Knowledge. Research on classroom knowledge is based on the assumption that, although there is wide variation among classrooms, teachers, and students, it is possible to codify in a general sense what teachers know that enables them to navigate within these settings (see Carter & Doyle, 1987). The construction of such knowledge is based on two frameworks: (a) an ecological perspective that focuses on the demands of environments and the impact of these demands on the thoughts and actions of participants, and (b) a schema-theoretic approach to the organization of knowledge and the comprehension processes by which that knowledge is connected to ongoing events in the environment. The convergence of these two perspectives leads to the assumption of a functional congruence between the structure of situations and the structure of knowledge that persons have of those situations. As a result of this assumption, classroom knowledge, therefore, is not a body of propositions or prescriptions derived from external disciplines or process–product studies, but, rather it is "situated" (see, for example, Morine-Dershimer, 1989) and is by conceptions grounded in the common experience of classroom events.

According to Doyle (1983), the central construct in the study of classroom knowledge is "task." Doyle suggests that a task has three basic elements: a goal to be achieved, a set of circumstances or "givens" under which the goal is to be achieved (i.e., a problem space), and a set of resources that can be used to reach the goal. Tasks are accomplished by interpreting the problem space (e.g., discovering what the problem of achieving order is in a particular class) and organizing resources (activities, rules, physical space) in ways that "fit" or account for the features of that problem space. Tasks organize situations for individuals and thus shape cognition and the organization of knowledge. They are, in other words, the medium through which persons intersect with their environments. They, therefore, define the "work" people must do (i.e., what they must think about), as well as the "treatments" embedded in situations. One learns about the world, that is, from what one does in accomplishing tasks. This task framework, then, becomes a theory of both knowledge and its acquisition.

The tasks of teaching. Studies of classroom knowledge have focused primarily on two key teaching tasks: (a) creating and sustaining order in classrooms, and (b) moving students through the curriculum. Doyle (1988) has recently integrated these two lines of inquiry into the concept of teaching as curriculum enactment.

Research on classroom order has concentrated primarily on the creation and maintenance of *work systems* consisting of (a) activities that organize students for working, that is, large group presentations and recitations, small group discussions, and seatwork segments; and (b) rules and procedures that specify actions for routine events such as obtaining materials, sharpening pencils, and turning in assignments (see Doyle, 1986; Leinhardt & Greeno, 1986). The most important feature of a work system for a class is the *program of action* that defines the character of order for particular segments of time and pulls students along specified paths (Doyle, 1986). For example, during whole-class presentations, students are typically supposed to attend to the explanation, respond to occasional questions, and take notes. During discussions, in contrast, students are to attend to one another, as well as to the teacher, and take appropriate turns at talking. When a program of action is not established or breaks down because of disruptions, orderliness has no situational foundation, and attempts to restore order are unlikely to be successful for more than a few moments.

A teacher's role in management has at least three dimensions. *First*, successful managers, defined by indicators of work involvement and achievement, *design* sensible and context-

sensitive work systems for their classes. In other words; they prepare in advance for how students will be organized to accomplish work and what rules and procedures will govern movement around the room and routine access to resources and materials. *Second*, successful managers *communicate* their work systems clearly to students through explanations, examples, practice, and feedback. *Finally*, successful managers *monitor* classroom events to make sure that the work system, including the curriculum flow (see Putnam, 1987), is operating within reasonable limits and to notice early signs of potential disruptions. By monitoring the flow of classroom activity, they reduce the need for frequent reprimands and other interventions to restore order and maximize the opportunity for students to engage in working with the curriculum (see, for example, Good & Brophy, 1987).

It is interesting to note that investigators in the information-processing and personal-knowledge traditions have reported a similar emphasis on rituals, routines, and principles of action in their studies of teachers' thinking.

Ecological studies of instruction and curriculum in classrooms have focused on the academic work, or tasks, students accomplish (see Blumenfeld, Mergendoller, & Swarthout, 1987; Doyle & Carter, 1984; Doyle, Sanford, Schmidt-French, Emmer, & Clements, 1985). In these studies it was found that assignments with different cognitive and procedural complexity for students were enacted in very different ways in classrooms. Familiar, routinized, and simple work was accomplished with ease. Explanations were clear and precise, students' misunderstandings were minimal, and work began quickly and proceeded efficiently. Moreover, there was high congruence between the announced work and the final products students handed in, and the teachers' criteria for evaluating products were consistently and often rigorously applied. On the other hand, complex assignments, in which students encountered novel information or problems and were required to make decisions in order to generate products, were much more difficult to enact. Explanations were longer, students frequently failed to grasp key points, and work sessions seldom flowed smoothly. Moreover, assignments drifted, that is, over time, the teacher often became more explicit about product specifications and the scope of students' decisions was narrowed. In writing assignments, for example, teachers often introduced model sentences or paragraphs for students to emulate when they had difficulty generating acceptable essays on their own. As a result, the announced work and the work students actually accomplished were often quite different.

Grant (1987, 1988) explored teachers' knowledge and understandings of the means to teach critical thinking tasks to students. By interviewing and observing teachers who were nominated for their successes in teaching critical reasoning, Grant described the organizational strategies teachers used to sustain tasks that were intended to promote critical thinking in their classrooms. Teachers in these studies shared a number of conventional strategies in teaching critical thinking (e.g. using writing to learn, discussing major topics thoroughly, interjecting humor to lighten otherwise serious work, responding supportively to student comments, ignoring incongruous student responses, and correcting erroneous thinking), but they also possessed unique strategies that seemed to emanate from teachers' organizing images about the demands of classroom work. For example, the imagery of the teacher in Grant's (1988) study (e.g., that learning in classrooms is an extended and difficult pilgrimage for students) appeared to help her to travel with students through the work in ways that promoted critical thinking. Importantly, engaging students in the intellectual risk taking of critical reasoning often meant a journey that was, according to Grant, "bumpy, circuitous, and unpredictable."

Teachers' comprehension processes. These studies of classroom order and academic work give a broad outline of teachers' knowledge. Additional work in the ecological tradition has concentrated on teachers' comprehension processes, that is, the processes by which teachers use their knowledge to interpret tasks and events. In an early study of teachers' comprehension, Doyle and Ponder (1977/8) examined the "practicality ethic" by which experienced teachers appeared to decide whether to use suggestions for classroom practice. They concluded that suggestions that were judged to be practical were framed in an instrumental language (i.e., describing a procedure, rather than a principle or ideal), were congruent with the circumstances and personal conceptions of the teachers, and involved a reasonably large return for the amount of energy and time invested. They also argued that these factors in teachers' judgments were shaped by the situational demands they faced in classrooms.

Pinnegar (1988) attempted to uncover the meaning of the phrase "with me" (e.g., "My students were really 'with me' today") in the language commonly used by teachers. Pinnegar conducted interviews with 40 experienced teachers who had recently served in the role of cooperating teacher. She asked the teachers to imagine they were talking to a student teacher and then explain how they knew a class was or was not "with" them and what meaning such cues had for their subsequent actions. Pinnegar's analysis suggested that the term described an important area of teacher knowledge. With this knowledge, teachers could react to subtle cues of boredom, disinterest, or fatigue and could redirect their own actions, change the pace of the lesson, or take other actions to engage students in work at hand.

Carter (in press-a, in press-b) examined detailed narrative records of classes taught by junior high school English teachers who differed on indicators of classroom-management success. The focus in these studies was on constructing interpretive frameworks or metaphors to account for how teachers appeared, through their comments and actions, to comprehend the problem of order in classrooms. The studies have suggested that experienced and effective teachers understood the problem of classroom order as one of guiding or steering the flow of action around potential obstacles. Managers who had difficulty sustaining order, on the other hand, often stopped the action to attend to misbehavior or build personal bonds with individual students. These comprehension studies are interesting in that they provide evidence of alternative ways in which teachers understand classroom events and connect those understandings to different consequences for the task of teaching.

Learning to teach. The task framework in research on classroom knowledge, by directing attention to how situations and thinking interact, has provided a rich ground for studies of learning to teach. In an early study framed in ecological terms, Doyle (1977) traced the processes by which student teachers learned to cope with the multidimensionality, simultaneity, immediacy, and unpredictability of the classroom environment. He noted that student teachers who successfully coped with classroom demands appeared to develop cognitive strategies such as rapid judgment, chunking, and differentiation that enabled them to simplify classroom complexity and accurately interpret events that occurred in front of them.

More recently, Pinnegar (1989) studied how teachers' knowledge and thinking about their students develop. The study involved extensive interviews with 12 secondary science teachers (four student teachers, four first-year teachers, and four experienced teachers with greater than 7 years of teaching experience) at five points in the semester (before school started, after 3 days, after 3 weeks, at the end of the first grading period, and at the end of the semester). The initial interview focused on obtaining infomation from the teacher about the image he or she projected or had of the class, the "personality" the teacher ascribed to the class, the nature of thought about the teacher's class when he or she was planning, and the typical kinds of interactions the teacher carried out with students. In addition, Pinnegar asked teachers to tell her about any advice they would give to a substitute teacher or to her if she were to decide to teach the class in the future. Beginning with the third interview, teachers were asked to talk about specific students they had nominated and who contrasted in terms of teachers' views of their ability.

Pinnegar's intensive work with these teachers suggested that knowledge and thinking about students takes on a different character with experience. Although all teachers tended to focus on information about student cooperation, experienced teachers appeared to have much more finely tuned cognitive skills in identifying resisters to cooperation and in talking about ways to engage them in classroom work. Student teachers' responses suggested that they thought cooperation was best achieved by developing good relationships with students. First-year teachers argued that it was important to know which students were likely to block progress, but they were not sophisticated at seeking out information about students that would help channel them into the curriculum. As one first-year teacher said, "You can only hope to sit on them." Experienced teachers, in contrast, thought often about students who resisted involvement and seemed to make clear distinctions between those who "could not" and those who "would not" do the work. They had a repertoire of strategies for using their knowledge to engage students in the work and to acquire new knowledge from students that could be used to sustain their interest.

Gonzalez (in progress) is attempting to examine the acquisition of "event-structured knowledge" (see Carter & Doyle, 1989) through extensive interviews, observations, and supervisory conferences with 15 student teachers. By tracking well-remembered events of these students and their reflections about them, Gonzalez is developing frameworks to describe this kind of knowledge growth. The work is preliminary, but she has found that student teachers' differential responses to particularly problematic events early in the student-teaching semester affect subsequent understandings of classroom events and might lead to a "ballooning" of dysfunctional interpretations of the *meaning* of student behavior and classroom episodes.

Points of Convergence. At their extremes, the personal and the ecological views represent clearly different stances on the form that knowledge of what teachers know can take. For extreme personalists, each person's knowledge is unique and cannot be codified across individuals without damaging important nuances of meaning. For the extreme ecologist, situations program what individuals think and do. Between these opposites, however, there is considerable overlap, with personalists stressing idiosyncratic variations close to the action of teaching and ecologists emphasizing common patterns and themes across situations. But both are interested in what teachers know and in how that knowledge is influenced by situations.

This sense of convergence of the personal and the ecological frameworks is apparent in two perspectives on teachers' knowledge use. Fenstermacher (1986) posits that teachers use information about teaching, regardless of its origins, not as a blueprint for acting, but as a resource for the practical arguments that undergird their actions. This concept of practical arguments acknowledges the personal voice of the teacher and of her or his individual interpretations of classroom events, but it incorporates general knowledge about content, students, learning, and classrooms. Information about the association between time and achievement, for example, can sensitize teachers to how time is spent in their classrooms and guide them in inventing ways to maintain or increase the quality of students' use of time. Morine-Dershimer (1988), in a reanalysis of stimulated-recall data from eight student teachers, concluded that uncovering practical arguments and then improving them by providing research knowledge could, theoretically speaking, be quite useful but, practically speaking, be both time consuming and difficult. Some optimism for the approach, however, is seen in Driscoll and Stevens's (1985) study. These authors found that experienced teachers used knowledge about teaching effectiveness as analytical categories for thinking about their teaching, rather than a guidelines for acting. Further attempts are currently underway to explore the nature of teachers' practical arguments and how these change with additional information (see, for example, Richardson & Anders, 1988; Richardson-Koehler & Fenstermacher, 1988).

Yinger has recently formulated a conception of teachers' knowledge use in interactive teaching (Yinger, 1986, 1987; Yinger & Villar, 1986). This conception is framed around the idea of improvisation. Yinger argues that teachers have a rich store of knowledge that enables them to make sense of immediate scenes and bring past experiences to bear on these scenes to invent, virtually on the spot, actions that fit these circumstances. He emphasizes that this knowledge, which encompasses past experiences and personal intentions and understandings, is "holistic and patterned" and might be inseparable from action in a situation. Thus teachers cannot necessarily talk

analytically about what they do in specific situations, because what they know is whole actions connected to situational frames. The trick in learning to teach is to acquire sufficient experience to develop a patterned language of practice with which to recognize what situations mean and how they might be responded to in particularistic ways.

These convergences of personal and ecological frameworks are promising. In particular they suggest that investigators interested in learning to teach should begin to tie knowledge to situations. This can be done by examining the tasks of teacher education, how these tasks are interpreted by those who are accomplishing them, and what can reasonably be expected to result from task accomplishment.

Pedagogical Content Knowledge

The final approach to studying teacher knowledge represents an attempt to determine what teachers know about their subject matter and how they translate that knowledge into classroom curricular events. There has been recent concern that the disciplinary knowledge that beginning and many experienced teachers possess poorly equips them for this transformation process (see, for example, Anderson 1989; Ball, 1988; Buchmann, 1984; Gomez, 1988). The process, to be sure, is multifaceted and complex. L. Shulman and Sykes (1986) suggest that pedagogical content knowledge includes:

> understanding the central topics in each subject matter as it is generally taught to children of a particular grade level and being able to ask the following kinds of questions about each topic: what are core concepts, skills and attitudes which this topic has the potential of conveying to students? . . . What are the aspects of this topic that are most difficult to understand for students? What is the greatest intrinsic interest? What analogies, metaphors, examples, similes, demonstrations, simulations, manipulations, or the like, are most effective in communicating the appropriate understandings or attitudes of *this topic* to students of particular backgrounds and prerequisites? What students' preconceptions are likely to get in the way of learning? (p. 9)

Tamir (1988) suggests that additional aspects of what he terms "subject matter specific" pedagogical knowledge include a teacher's knowledge of students' interest and motivation to learn *particular* topics within a discipline, a teacher's understanding of how to make outside-school settings (e.g., museums and laboratories) quality learning environments for special content areas, and a teacher's discipline-based knowledge of special needs for testing and evaluating students' work (e.g., practical laboratory tests in science).

Inquiry into teachers' pedagogical content knowledge has been particularly active since about 1985, and yet it is important to preface a review of representative studies by saying that the work is still in its early stages. General statements about what teachers know about content in their fields and its transformation into forms accessible to students is clearly premature. But what has been learned to date has signaled concern about the limited pedagogical content knowledge of new teachers and has enlivened the present debates concerning the redesign of teacher education programs (see, for example, Grossman & Richert, 1988; L. Shulman, 1986, 1987).

Studies to date of teachers' pedagogical content knowledge have addressed some, but certainly not all, of the different dimensions described above. These studies have examined teachers' pedagogical content knowledge in several different disciplines.

Mathematics. Representative studies in the area of mathematics include the work of Carpenter, Fennema, Peterson, and Carey (1988); Leinhardt and Smith (1985); and Steinberg, Haymore, and Marks (1985). Carpenter et al. investigated the pedagogical content knowledge of 40 first-grade teachers. Specifically, these researchers focused on teachers' knowledge of distinct types of addition and subtraction problems, their understandings about the strategies children use to solve different problems, their abilities to predict the manner and success of their own students in solving different problem types, and the relationship between these aspects of teachers' pedagogical content knowledge and their students' achievement. Multiple measures and techniques were employed to assess teachers' knowledge, including tasks requiring teachers to represent different problem types, to determine the relative difficulty of pairs of problems presented to them, to use information presented to them vis-à-vis videotapes to predict students' problem-solving strategies, and to predict how a small sample of their own students would solve different addition and subtraction problems.

Although teachers had little trouble making distinctions among different kinds of problems, this knowledge did not appear to be logically linked to their considerations when deciding on the relative difficulty of different problems. Nor did teachers' general knowledge of problem difficulty appear to be related to their ability to predict their own students' success in solving different problems. However, teachers' ability to predict whether their own students could solve different kinds of problems was significantly related to student achievement. These authors suggest that one possible explanation for teachers' inability to make coherent connections among the different aspects of pedagogical knowledge they studied was their lack of exposure to an existing, rich, knowledge base for how students solve addition and subtraction problems.

Other studies in the content area of mathematics have looked more directly at how subject-matter knowledge is translated into curricular events in classrooms. Leinhardt and Smith (1985), for example, not only investigated teachers' knowledge of mathematical computational procedures that they taught, but also assessed their knowledge of lesson structure and teaching routines. Leinhardt and Smith videotaped classroom lessons on fractions, obtained teachers comments on these lessons, and ultimately mapped complex relationships between teachers' subject-matter knowledge and their strategies and routines for engaging students in the content.

Similarly, Steinberg, et al. (1985) used interviews and observations to explore possible links between four new secondary teachers' differing levels of knowledge of mathematics and the ways they structured instructional tasks for their students. These researchers collected information about teachers' intellectual biographies; their perspectives on and personal understandings of their discipline; their sense of the organization,

crucial topics, and relative difficulty of concepts in algebra; and their general and subject-specific ideas about teaching. Results from this work suggested a relationship between the quality of an individual's knowledge of mathematics and the kind and quality of lessons carried out in classrooms. Specifically, a relationship existed between greater knowledge of mathematics and, for example, the use of more conceptual teaching strategies, the instructional practice of identifying relationships among concepts inside and outside the mathematics discipline, and the ability to engage students in active problem-solving activities.

Social Studies and English. Cases of pedagogical content knowledge have been conducted in other content areas as well. These studies include a focus not only on the substantive knowledge of teachers and its ties to transformation of content but also on the disciplinary perspectives, orientations, and beliefs of individuals. Wilson and Wineburg (1988), for example, studied four novice social studies teachers who differed widely in the focus of their academic studies. One teacher viewed history from the preparatory lens of anthropology, one from international relations and political science, one from American studies, and one from American history. Cases developed through extensive interviews and observations with these teachers indicated that these varied backgrounds held great sway on their conceptions of the role of factual knowledge, the place of interpretation, the significance of chronology and continuity, and the meaning of causation in history, and, ultimately, the processes and content of their instruction.

Similarly, Grossman's (1987) work with two beginning English teachers revealed that different orientations to subject matter influenced how they planned to carry out content in their classrooms. Grossman's extensive interviews with and observations of these two teachers as they were learning to teach suggested that they had very different motivations for becoming teachers and possessed quite different orientations to the subject matter of English. These differences surfaced in planned strategies and focus areas of their lessons. For example, Colleen, whose first love was the text and texture of the English language itself, focused her instruction on powerful passages, reading of words, and attention to detail in literature. Martha, in contrast was less enamored with stressing detail in the literature than with using literature to elicit student reactions and responses about the human condition. Grossman found that these teachers' differences in orientation affected their instructional strategies for teaching writing as well and, importantly, to some extent shaped the impact of their professional preparation.

Gudmundsdottir's (in press) four case studies of veteran teachers of history and English echo themes similar to those that surfaced in the studies described above. Interviews with and observations of teachers, as well as the graphic pedagogical models of their disciplines constructed by these teachers, suggested strongly that their disciplinary backgrounds, orientations, substantive knowledge, and beliefs affected their planning and instruction, the goals they set for themselves and their students, the organization they developed for different units of study, and the means of communicating their own ideas and values about the content to students.

Learning to Teach Content. Although learning to teach subject matter is a priority in this research program, only a few studies in this area have actually been completed. Studies in this tradition by Ball (1988) and by Gomez (1988) were reviewed earlier in this chapter as representative of learning to teach research. Additional studies with a subject-matter focus include those of Duffy and Roehler (1986) and their colleagues (see Michelson, 1985, 1987; Roehler et al., 1987) on changes in teachers' knowledge structures during course instruction in reading methods. Using techniques that result in graphic representations of an individual's ordering of concepts and their relationships in an area (e.g., semantic mapping and ordered-tree techniques), these researchers asked reading-methods students to create representations of their content knowledge prior to their methods instruction, during methods instruction, and after such instruction had been completed. These products were rated for their arrangements, relationships, and integrations and were analyzed for their levels of complexity at different times.

Although the degree of change was found to be unique to the student, these investigators have described trends in the kinds of knowledge changes made at the various points of assessment. For example, between baseline and second maps, there tended to be a "spreading" of students' understanding of their discipline. Students appeared to have added to their baseline knowledge and to have been differentially successful in developing some new frameworks for their content. At the next interim point, students' maps, in general, were more cohesively connected and seemed to indicate that they had gone through a process of reconceptualizing their content. At the final point of assessment, after students had completed their methods course, further development in knowledge structures occurred for some students, although at this stage the degree and nature of the growth was much more difficult to capture and describe.

Summary. Taken together, these studies suggest that differences in teachers' disciplinary knowledge, background, experiences, and orientations have a significant impact on how teachers organize instruction and represent the substance of the curriculum to students. This line of inquiry is important in that is focuses on a neglected aspect of knowledge about teaching and attempts to capture the collective understandings and traditions of the profession about how subject matter is to be represented in classrooms.

From a learning-to-teach perspective, pedagogical content knowledge is a domain distinct from, but not unrelated to, practical knowledge. The major difference is that pedagogical content knowledge is to a greater extent grounded in disciplines and in formulations related to school curriculum and the collective wisdom of the profession than practical knowledge. It is, in other words, more formal than personal and situational knowledge. The learning-to-teach problem, therefore, is more one of translating knowledge from one form to another, from propositional to procedural, than of unraveling the meaning of complex experiences. At the same time, curricular goals, as well as forms of representation and modes of instructing, are often quite personal and must be understood, if they are to be enacted at all, as classroom events. It might well be that

pedagogical content knowledge and classroom knowledge are not ultimately that different for the learning teacher.

A final note: One suspects that teachers, especially at the secondary level, are more familiar with pedagogical aspects of teaching from their apprenticeship as students than they are with the practical knowledge gained primarily from experience as a teacher. This differential familiarity is likely to affect how preconceptions and expectations operate in learning to teach.

CONCLUSIONS AND RECOMMENDATIONS

Throughout the chapter issues of findings, implications, and methods have been discussed in conjunction with specific research domains and studies. In this final section, some of the broader themes raised by this review are addressed.

This survey would seem to have demonstrated the value of considering knowledge and learning in studies of learning to teach, as well as the clear interdependency of these two fields. How one frames the learning-to-teach question depends a great deal on how one conceives of what is to be learned and how that learning might take place. At the same time, an understanding of teachers' knowledge is enhanced by probing more deeply the question of how that knowledge is obtained or changes over time. It is likely, therefore, that these fields will move forward together.

There are also indications in this literature that greater clarity on issues of both knowledge and learning is needed for productive research on learning to teach. There is still a tendency in studies of teachers' knowledge to focus on characteristics of what teachers know (e.g., their knowledge is complex, diverse, idiosyncratic, rich, holistic, personal) or on topics about which they think (e.g., they know about routines, students, images, curriculum). Less attention is given to the substance of that knowledge, to what teachers actually know or need to know about classrooms, content, and pedagogy and how that knowledge is organized. The latter task is considerably more difficult but is likely to be quite productive.

Similarly, greater thought needs to be given to a theory of learning in teaching. There are clear and promising signs of an interest in constructivist theories of learning, but the formulations are still primitive. More discussion needs to be directed to what it means to learn to teach, rather than simply to what is learned in which settings.

The final message of this review is twofold. *First,* the range and complexity of what is learned in teacher education are enormous. Unraveling knowledge and learning in teaching will be a very difficult task. *Second,* progress along the lines sketched here will lead to radical reforms in teacher education both in the conceptions of what the knowledge base for teaching is and in approaches to curriculum and pedagogy (see, for example, Woolfolk, 1989). Whatever the future holds for inquiry, it is now evident that teachers' knowledge is not highly abstract and propositional. Nor can it be formalized into a set of specific skills or preset answers to specific problems. Rather it is experiential, procedural, situational, and particularistic. It will be necessary, therefore, to develop forms of representation that capture these essential features of what teachers know with a high degree of situation and task validity.

This characterization of teachers' knowledge does not mean that teaching can only be learned by apprenticeship in field settings. "Natural" settings can be quite confusing (Smylie, 1989), and novices might well direct their attention to irrelevant aspects of the stream of action. Constructed and guided experiences designed on the basis of an analytical understanding of teaching events are often more instructive than natural settings, because the essential cognitive dimensions are more easily accessible. Such experiences, in turn, provide the cognitive foundation for knowledge construction in more natural environments.

Processes used to deliver teacher education content to novices must not only reveal pedagogical problems but also bring out ways of thinking about these problems and provide opportunities for novices actually to practice problem solving. Several observers (e.g., Brophy, 1988; Carter, in press-a; Carter & Richardson, 1988; J. Shulman & Nelson, 1989) have recently suggested that the use of cases holds promise for achieving these ends. But it is important to note that evolving a case literature to capture the complexities and contingencies of classroom life and to convey the kinds of knowledge necessary to teach successfully is likely to be an expensive and labor-intensive enterprise (see Carter & Unklesbay, in press). The 1990s should speak to our capacity to support a commitment to a reconceptualized teacher education process.

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