1-19

A Developmental-Constructivist Approach to Teacher Education

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In the Developmental Teacher Education (DTE) program at the University of California at Berkeley, Piagetian developmental theory and research is used as core knowledge for preparing elementary school teachers. Developmental-constructivist principles of knowledge acquisition are particularly well-suited for this purpose because they have implications for what and how children are taught, how progress toward expertise in teaching is conceptualized, and how teachers are educated. The authors describe the 2-year, postgraduate program, whose features include small cohorts of students, course work organized to address key topics repeatedly and hierarchically, multiple student teaching placements in diverse settings, and a master's project on a teaching-learning issue. They also comment on teaching practices of program graduates and the development of their understanding of children, learning, and teaching during and after graduation from the program.

Developmental Teacher Education (DTE) began as an experiment in teacher education by faculty in educational psychology in the Graduate School of Education at the University of California at Berkeley about 12 years ago (Ammon, 1984). The program was designed to evaluate the hypothesis that elementary school teaching and learning could be improved by using developmental theory and research as the unifying conceptual core for teacher preparation. In contrast to the 1-year postbaccalaureate professional program that is still standard in California, DTE comprises 2 postbaccalaureate years and combines the master of arts degree with the credential for teaching in the elementary grades. The extra year and master's degree reflect additional time spent interweaving an in-depth study of human development with more traditional study of teaching methods and with experiences in field placements. The goal is to provide teachers with knowledge to better understand and hence to better guide the teaching-learning process by working together to develop a pedagogy that integrates knowledge of the developing child with knowledge of subject matter.[1]

The program attracts highly qualified students from major colleges and universities across the country, and the current application-to-acceptance ratio exceeds 3-to-1. Our graduates frequently play leadership roles in their schools, even early in their careers. They remain committed to a developmental approach to teaching years after they graduate, and they continue to refine their understandings of what a developmental approach entails (Levin & Ammon, in press). We attribute the success achieved to several factors: offering a conceptually coherent program to prospective teachers, basing the coherence on a developmental constructivism that is sufficiently comprehensive to bind together the disparate components of teaching as well as the parallel components of a teacher education program, attracting students willing to suspend their desire to learn the "right way" to teach as quickly as possible while in-

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[1]In addition to the authors, faculty primarily responsible for the design, direction, and implementation of the program since its conception include Nadine Lambert and Elliot Turiel. A unique feature of the program is the participation of research faculty from divisions of the School of Education other than Educational Psychology. Much of the success of the program is due to the contributions of Anne Haas Dyson, Lily Wong Fillmore, Larry Lowery, Pedro Noguera, Robert Ruddell, and Herb Simons.

vesting the time necessary to construct, for themselves, ways to put complex theory and research to work in their classrooms, and including research faculty as instructors and a program of research that serves as an impetus for program development.

Developmental Constructivism

Research and theory in cognitive science, sociology, and anthropology have combined to stimulate widespread recognition in the education community of a conception of learning as a constructive process. Depending on the source, constructivist learning is viewed as more concerned with understandings achieved through relevant experience than with accumulated facts received from others, more imbued with meaning, more domain or situation specific, more influenced by social and cultural contexts, and, in general, less purely cognitive and less governed by abstract principles than traditional conceptions of learning.

Educators' recent enthusiasm for constructivism follows 50 years of opposition within developmental psychology to the dominant associationist and behaviorist views of learning. Much of the success of the opposition to behaviorism can be attributed to the Genevan studies of children's conceptual development in various domains of knowledge. Contrary to associationist principles, these studies demonstrated that children's thinking is qualitatively different from, and not just an imperfect copy of, adult thought. That is, children's thinking contains understandings of the world that cannot be attributed to patterns of association or external reinforcements. This insight has influenced many programs in early childhood education but as yet has had limited influence beyond the primary grades (e.g., National Association for the Education of Young Children, 1991). Piaget (1976) summarized the implications of this research for education: In brief, understanding, not rote learning, is important in education, and to understand is to invent.

In the Piagetian (e.g., 1964) view, learning in the sense of making associations (e.g., memorizing) is subordinated to a more fundamental process of active assimilation whereby new information is interpreted in terms of existing understandings. These understandings evolve as the lack of fit between newly assimilated information and old understandings forces a reformulation. Reformulation takes time as bits and pieces of information are recombined, and higher-level understandings typically emerge after repeated (recursive) interactions with the problem at hand. Although educators generally believe that an understanding-based model of learning is integral to a constructivist approach to learning, debate continues over the essential components of learnng. Especially controversial is the Piagetian notion that new constructions are organized into sequential levels or stages of understanding through an internally regulated process of contradiction resolution (equilibration).

We have found Piagetian theory most useful in comprehending how understandings of the content of schooling are acquired, because the complexity of the theory matches the complexity of the problem. For example, despite researchers seeking to demonstrate that complex subject matter such as fractions can be taught to children at ages younger than those attributed to Piaget, and despite years of teachers' modeling and reinforcing correct solutions to fraction problems, understanding fractions continues to be difficult for fourth, fifth, and many sixth graders. To understand this difficulty requires a theory of learning that incorporates levels of development and a self-regulated learning cycle such as that proposed by Piaget. Piagetian theory is also useful in education because of its concern with the content of schooling. As a foundation for educational practice, including teacher education, however, its educational implications need to be approached somewhat differently than usual.

Piagetian Stages Revisited

The elementary school teacher is confronted with challenging educational issues each day. On one hand are the multiple subjects to be taught; on the other are the 30 or so children in the class at different levels of achievement. Children's achievement is difficult to understand because it varies from one subject to another and the ordering of subject matter that defines achievement within each subject area (scope and sequence) is typically not well-understood. Help is available, however, from basic Piagetian research on the development of knowledge in mathematics (Piaget, 1965; Piaget & Inhelder, 1965; Piaget, Inhelder, & Szeminska, 1964), physical science (Inhelder & Piaget, 1958; Piaget, 1960), and literacy (Ferreiro & Teberosky, 1982;

Goodman, 1990). Until recently, this research has not been used effectively in education because it has been interpreted as being directed primarily at demonstrating general stages of intellectual development (sensorimotor, preoperational, concrete operational, and formal operational)—stages that seem to reduce intellectual development to an abstract logic that sets limits on knowledge acquisition across the various subjects and only serves education by cautioning teachers against expecting too much from their students. To some extent this interpretation is appropriate, but another side to stage analysis is of more use to teachers and of equal importance to the theory. Analyses of levels of conceptual development within each domain underscore the conceptual attainments unique to each subject area, and, in so doing, reveal conceptual hurdles that cause children difficulty in school. Identifying the nature of a conceptual hurdle makes it possible for teachers to devise curricula to address the difficulties. The difficulties frequently involve confusions among different components within a subject domain, such as those encountered by children as they acquire increasingly more complex understandings of measurement through differentiating and integrating spatial and numeric concepts. For specific examples in mathematics, science, and literacy, see Black (1985, 1986, 1989) and Black, Ammon, and Kroll (1987).

In addition to the analyses of domain-specific conceptual development, a critical component of Piagetian theory and research for educational practice is a theory of knowledge, or genetic epistemology, that provides common points of reference across knowledge domains. For example, developing abilities to classify and to order are key concepts in Piaget's epistemology. Paralleling the development of part-whole relationships that relate subclasses to higher-order classes are part-whole relationships that characterize numbers, as well as part-whole coordinations between letters, words, and meaning in developing literacy. If the unique quality of each domain is also considered, teachers can use knowledge of genetic epistemology to compare individual learners' achievements across subjects.

The vertical dimension of the Piagetian epistemology within each domain is helpful for coordinating early conceptual attainments with those targeted for the upper grades. For example, a strong conceptual linkage exists between classifying by shapes and colors, solving Pattern Block puzzles, solving missing-addend problems, doing algebra, and understanding mathematical group structure. This kindergarten-to-college linkage is one of the reasons that Piagetian-based mathematics programs for young children, such as that produced by Baratta-Lorton (1976), retain their immediate popularity with teachers, while also providing children with a background that can be linked to higher mathematics.

Social Interaction as a Resource for Conceptual Development

Although Piaget included social interactions among the major influences on intellectual development (e.g., Piaget, 1976, pp. 95-101), his research focused on detailed studies of conceptual development within content domains and the constructive process whereby increasingly higher level understandings are achieved (equilibration). Critics of the theory have taken Piaget's research too literally in attributing to the theory a conception of a learner immune to social influences. This interpretation has persisted despite Piaget's (1948) insistence that cooperative interactions among peers, and not the inherently nonreciprocal interactions with adults, are the source of the motivation for, and the content of, children's development.

Recent research in the Piagetian tradition both in and outside of the classroom has demonstrated the role peers play in providing novel perspectives and cognitive conflict that promotes intellectual development (e.g., Damon, 1984; Doise & Mugny, 1984; Murray, 1972). In shifting the locus of intellectual development from the solitary individual to the individual in a highly interactive social milieu, major implications for educational theory and practice have opened up, providing a common theoretical basis for appreciating and thinking about the benefits of innovative educational programs such as cooperative learning (e.g., Johnson, Johnson, Holubec, & Roy, 1984). Although questions remain about what kind of social interactions promote what kind of learning and whether all children benefit equally (e.g., Black et al., 1987), several lines of research support a change from reliance on whole-class, teacher-led instruction to heterogeneous small-group activities as potential sources of new knowledge and inspiration (e.g., Dyson, 1987).

Conditions for Teacher Learning and Development

The first task in structuring a teacher education program based on developmental constructivist principles was to assemble a curriculum (within limits acceptable to California's Commission on Teacher Credentialing) whose components combined to promote a comprehensive pedagogy that would make sense to prospective teachers. From the outset, our approach has been to have students continuously engaged in three areas of study: developmental theory and research, teaching methods, and field studies. The goal is to foster a synthesis during the 2 years that is identifiable as developmental teaching. At the core of that pedagogy is a conception of the acquisition of knowledge in each subject domain as a series of steps that involve both differentiating and integrating key concepts through the elementary grades (i.e., conceptual strands such as number and measurement in math or plot and character development in narratives). Although the steps can be conceived of as a linear sequence, progress is better described as helical and interactive (Black, 1985, 1986, 1989). In addition to pushing the idea of general stages into the background, integrating ideas about social interaction as a source of development, and extending a genetic epistemological analysis to areas of the curriculum beyond math and science, the goal of a complete pedagogy required us to identify teaching methods that engage children in constructing understandings along the various strands of content.

Student differences in backgrounds and achievement levels in key subject areas similar to those that confront elementary teachers confront teacher educators. In addressing these differences with adults learning to teach, we have attempted to incorporate the same developmental principles that apply to children learning in schools. As with children's learning, many educational objectives for student teachers originate from sources external to the individual, and therefore we needed to establish conditions that would maximize the likelihood of students making our objectives their own—for example, by ordering courses in a manner that helps students acquire increasingly higher-order understandings and by allowing time for the recursive, self-paced constructive process. As we have come to appreciate the value of collaboration in promoting learning, we have included collaborative activities in most core courses. We also needed to construct a model of teacher development that could be used to chart the conceptual progress of individual teachers and to aid us in understanding and devising means to overcome the hurdles involved in learning to teach. That is, we needed an epistemology for describing teacher development that would capture the developmental-constructive process of differentiating and integrating developmentally appropriate ways to engage in, and think about, teaching.

Program Structure

The program begun by the 15-20 students each year consists of a series of core seminars, as well as a series of introductory teaching methods courses and practica. The students progress through the program as a cohort and, with few exceptions, do not share courses with students in other programs. They are involved in classrooms as participant-observers, student teachers, or both throughout the 2 years, often in the classrooms of program graduates.

The First Year

Core program seminars. Throughout the first year, the series of core program seminars emphasizes developmental theory and research first and classroom applications second. In the first seminar—Cognitive and Language Development—students do classic Piagetian stage assessments of conceptual development in logic, mathematics, and science based on clinical interviews with children. At this point, the important conceptual hurdle is to see children's errors not simply as errors but as developing understandings that make sense to the children and are necessary for progressing to better understandings. Students are then asked to use the knowledge gained from these assignments to analyze the difficulties and successes that children in their classrooms encounter with subject matter they choose themselves. Here, the first effort is made to shift the seemingly natural way to think about the results of administering Piagetian tasks as assessing general cognitive levels to identifying developmental or conceptual milestones in different curriculum areas, while also thinking about individual students in terms of their achievement of these milestones. A similar approach is then taken to language development. Students collect

samples of modes of language use (speaking, listening, reading, writing) from children at different ages and analyze development in terms of differences in phonology, morphology, syntax, semantics, and pragmatics, while reflecting upon how such development can be assessed and fostered. The seminar ends with a general discussion of how developmental theory and research might be used to improve upon the sequencing of curriculum and the methods of teaching observed in student teaching placements.

The second core seminar—Social and Moral Development—provides a theoretical background for the search undertaken by each DTE student for an approach to classroom management that promotes both social and intellectual development of children and that works for the individual teacher. Some psychoanalytic and behaviorist theory is covered, but the emphasis is on developmental theories (e.g., Piaget, 1948; Kohlberg, 1963, 1966; Gilligan, 1982; and Turiel, 1989) and their application in the classroom. Students analyze the forms of behavioral control used in their student teaching placements and assess levels of moral and conventional thinking in children. One goal is for the prospective teacher to differentiate the relative importance of moral and conventional issues in the classroom (Turiel, 1989) and to identify the types of social interactions that foster development in both areas. Students are introduced to the developmental research on social interaction among peers as a source of both social and intellectual development. This research is used as a basis for differentiating forms of peer interaction (e.g., peer tutoring, cooperation, collaboration) that promote different educational goals. The result is a complicated matrix of issues for teachers to take into consideration: intellectual development, social development, forms of social interaction, and methods of teacher control. In practice it is difficult to address all educational goals simultaneously, but the developmental research makes it possible for the beginning teacher to understand the complexity and to work toward establishing a developmental classroom in a self-directed manner.

The last core seminar in the first year—Psychological Development—introduces Erikson's stages of psychosocial development. Systematic observations of children's social behavior are made inside and outside the classroom, and Erikson's stages are used to gain insight into the developmental needs expressed in children's behavior and to consider ways to address these needs in the classroom. Knowledge of the stages helps beginning teachers establish an appropriate balance between their sometimes unrealistic expectations for influencing their students' lives in general and their ability to establish a learning environment where industry is channeled, competence acquired, and autonomy fostered. The final project for the year is to use computer-based bibliographic resources to develop a prospectus for a master's project that applies developmental theory and research to teaching and learning.

Methods courses. Throughout the first year, students take courses on methods for teaching mathematics, reading, language arts, sciences, and social studies. They review and critique state curriculum frameworks, basal series, and computer-assisted instructional programs. They learn about lesson planning and carry out plans in their student teaching placements. When the program began, we did not control the methods courses, which were quite traditional, and consequently we did not worry about integrating theory and methods until the second year. At that time a large gap existed between the teaching methods advocated in curriculum frameworks and texts and those advocated within DTE. Over the years, however, the methods courses have become increasingly compatible with a developmental perspective, as new instructors have incorporated recent pedagogical advances in their disciplines.

Our mathematics and science methods courses are now taught at Berkeley's Lawrence Hall of Science, which has a long history of developing "manipulative-based" mathematics and "hands-on" science programs that are compatible with constructivist theories. Instead of using traditional textbooks for mathematics instruction, students use *Family Math* (Stenmark, Thompson, & Cossey, 1986), a collection of hands-on activities that are used with and without parent involvement, and books by Burns (e.g., 1988; Burns & Tank, 1987) that present guided discovery lessons for specific grade levels. In addition to the state frameworks, the National Council of Teachers of Mathematics (NCTM) Curriculum and Professional Standards form the backbone of the course. Assignments include keeping records of the mathematics engaged in at student teaching placements, implementing lessons while keeping records of student work, incorporating cooperative learning and writing into math lessons, conducting a traditional form

of mathematics assessment together with an alternative form on the same topic, and completing a *Family Math* assignment that includes parental involvement. Students are taught to teach science by doing science (observing, hypothesizing, organizing, and communicating) at every grade level and not as another reading activity concerned with scientific discoveries. Their appreciation of science as a problem-solving activity is extended, and they are helped in developing science activities by having access to new programs developed at the hall (e.g., the Full Option Science System, FOSS, 1992, a K-6, hands-on science curriculum), which they put to use in their student teaching placements.

The situation is similar in reading and language arts. Reading is presented as a meaning construction process based on the language and social-cultural background of the student. On a continuum from a skills emphasis (e.g., phonics) to whole language instruction, the approach is near the middle; teachers are expected to acquire strategies for directing students' thinking about spoken and written communication—strategies that, over time, become strategies for the students as well. Student teachers are asked to gain a perspective on the context for schooling by attending at least one community event (e.g., a school board meeting), to plan lessons in small groups (e.g., on developing reading comprehension), and to design a unit of instruction for the classroom where they are student teaching.

The course work in language arts instruction extends and broadens the appreciation of the structural and functional diversity in child language development, which was introduced in the first core program seminar. Now the focus is on how facility with language is acquired and how the interplay between oral and written expression serves learning. Students use *The Primary Language Record: Handbook for Teachers* (Barrs, Ellis, Hester, & Thomas, 1988) as a guide for doing classroom language analyses, including taping their own interchanges with students. They are also asked to engage in a daily writing routine with a small, heterogeneous group of students and to keep a record of student performance and of their own progress as facilitators of language development.

In social studies, the basic premises and learning goals of the California History-Social Science Framework (e.g., cultural understanding, democratic and civic values, and social participation) are reviewed and critiqued. Students participate in model curricula (including available computer software) and work in groups developing lessons that embody an integrated and multicultural curriculum. The parallel value of collaboration between teachers in developing social science projects and collaboration between students in completing the projects is emphasized.

Multicultural education courses. The deteriorating conditions of schooling in urban settings and the rapidly changing demographics in California's schools have led to the addition of course work directed at how sociocultural and linguistic factors influence teaching and learning and to increasing the number of field placements in classrooms serving highly diverse communities. Multicultural education issues are also addressed with increasing frequency within the core program seminars and methods courses.

One of the assumptions of the course on urban education is that the problems encountered in inner city schools cannot be addressed without recognizing their link to social and economic conditions nationally (e.g., deindustrialization, migration and immigration, and cutbacks in federal funding for domestic programs) and locally (e.g., deterioration of urban communities, poverty, and crime). Each student writes a paper on a contemporary urban school problem, based upon a combination of readings and field research in local public schools. The course on teaching linguistic and cultural minority children addresses how educational programs can be adapted to respect and accommodate the diversity of students' cultural backgrounds, particularly the special needs of children from language backgrounds other than English. Individual differences in language learning are studied along with bilingual and second language teaching methods that support the acquisition of English, as well as instructional approaches that maintain and develop native language skills. The course project involves teams of students developing curricula that address cultural and linguistic minority issues.

Student teaching. The structural component of the program that is most easily identified as informed by a developmental-constructivist perspective is the distribution of student teaching. Rather than establishing conditions for learning to teach through modeling of skilled teachers observed in one or two intensive placements, as is customary in California, the same amount of time in the classroom is distributed over 2 years and

five student teaching placements. In addition, each student teacher is placed at several grades and in several socioeconomically and culturally diverse communities. To encourage and monitor a reflective, problem-solving approach to teaching, students keep journals on their activities, which receive written responses from campus-based teaching supervisors each week.

Student teaching is introduced gradually. During the first fall semester there are two 8-week placements in which students participate in classrooms two mornings per week. They take responsibility for some small group work and for single whole-class lessons while reserving time to observe closely the dynamics of the classroom and the behavior of individual children. There is one primary and one upper elementary classroom placement in two communities with contrasting sociocultural characteristics. The third placement (2 full days per week) is the first of three regular student teaching placements where students assume larger-scale responsibility for instruction and curriculum.

Student teaching seminar. Small cohorts provide conditions for students to collaborate and experiment with future collegial relationships. The weekly student teaching seminar fosters such relationships, as practical issues that arise in placements are discussed, and as efforts are made to integrate theory with practice. The organization of this seminar is complex and important to the success of the program. Sometimes students meet with individual supervisors, sometimes in first- or second-year cohorts, and frequently as a total group for discussion, to hear guest speakers, or both. Diverse approaches to classroom management are contrasted and modeled—for example, Jones's positive classroom discipline (Charles, 1989, chap. 6) and Watson's developmental discipline (Watson, Solomon, Battistich, Shaps, & Solomon, 1989). Each year a program retreat is held off-campus where the students collaborate and use their special talents to present and participate in workshops on topics that are either of special interest or are not otherwise well covered in the program—for example, art, music, dance, and physical education.

By the end of the first year, DTE students typically view the methods courses and student teaching placements as the most important contributors to their development as teachers, which they also tend to see as going all too slowly. The theory seminars are viewed as important but less relevant to the demands of the classroom. Despite the special characteristics of the DTE program, it is quite likely that, without the second year, the program would receive reviews similar to those reported by other programs where students tend to denigrate their academic preparation and see their student teaching placements as the primary source of their development as teachers.

The Second Year

One of the first outcomes we became aware of when evaluating the program was that when second-year students returned from summer break, they were at a higher level of integration of ideas presented in the program and at a higher level of involvement in the program than when they left. Two factors are probably at play here—the break provides a time for consolidation of understandings and looking ahead to graduation increases motivation.

Core program seminars. The core program seminars for teaching mathematics, science, and literacy are now directed at integrating theory and practice within a developmental framework. Theoretical and practical material covered separately in the first year is reintroduced at a higher level for purposes of integration. Assignments are as much curriculum development as lesson planning. In seminars, instructors reduce lecturing by at least one-half. Student-led activities increase accordingly. In the first seminar, students study selections from the research of Piaget and his colleagues on topics in mathematics (e.g., number, space, geometry, probability) with reference to their implications for practice and then compare them with the work of educators who have sought to apply developmental theory to school learning or have proposed methods that are consistent with a developmental approach (e.g., Baratta-Lorton, 1976; Burns, 1988; Burns & Tank, 1987; Kamii, 1985; Kamii & Joseph, 1989; and Lampert, 1986) as well as with educational proposals such as spiral curriculum, learning cycles, and multiple embodiments as described by Resnick and Ford (1981). To integrate this material, students are asked to reconsider the ordering and mode of presentation of concepts in several strands of the mathematics curriculum (e.g., number, measurement, probability) and to conduct a teaching project that includes curriculum development,

preassessment, teaching, postassessment, and remediation. Frequently in completing the assignment, the conceptual continuum is revised, as the beginning teacher acquires a firmer understanding of teaching as a balance between teacher input and the learner's prior knowledge. In science the focus also shifts from using already developed science curricula to constructing hands-on science units using a sourcebook of resources developed by Lowery (1985).

The class project for the final core seminar on the development of literacy is a milestone for students in the program. On the basis of their first year's course work in reading and language arts and new material on developmental perspectives on literacy (e.g., Bereiter, 1979; Chall, 1983; Ferreiro & Teberosky, 1982; Goodman, 1986; Goodman, 1990; Palincsar & Brown, 1986), as well as developmentally compatible perspectives (e.g., Calkins, 1986; Graves, 1983), students are asked, as a group, to formulate a developmental approach to reading and writing instruction for children from prekindergarten through grade 6 and to produce a document that describes and explains the approach for an audience of teachers. The goal is not to prescribe an entire curriculum in detail but to provide a rationale and enough examples across grades and curriculum topics that readers will understand how they might design developmental literacy programs on their own. Students are encouraged to include ideas for how to meet the needs of diverse learners including those who are linguistically and culturally different and those who are learning disabled or handicapped. The students begin the project by reading and critiquing the work of the previous year's graduates in the same seminar.

Additional course work. DTE students complete a minicourse on legal issues in educational practice, concerned with pupil and teacher rights and with teacher responsibilities under the law, and a course in assessment of exceptional pupils in regular classrooms (mainstreaming), where techniques for addressing the various handicapping conditions are introduced. Early in the history of the program students and faculty were interested in spending time on integrating an approach to special education within our developmental framework. Much of the energy for program development in that direction has shifted toward addressing issues of linguistic and cultural diversity, which is of more immediate concern to our students. This illustrates how even an extended preservice teacher education program cannot fully address all of the educational issues that teachers face.

Student teaching and student teaching seminar. Student teaching increases in intensity and in scope during the second year. The most intensive placement is in the fall semester (3 full days per week). It includes a 2-week solo takeover of the class. Increased responsibilities during student teaching parallel increased understandings of how an educational program is coordinated overall and how to orchestrate differing numbers and mixtures of students. Responsibilities include classroom management over an extended time, planning lessons for the year, and record keeping. To allow time for conducting the master's project during the final semester, student teaching is reduced to 2 full days per week.

Two possible goals for this last placement remain, however: either to fine-tune teaching competencies that were not mastered in previous placements or to gain experience teaching in a large, multilingual urban school where many of the students are recent immigrants from Southeast Asia and Latin America. Most of the second-year students are placed in one school, where they can collaborate on addressing cultural differences and put into practice what they have learned about the importance of understanding the child's community for understanding the child while also expanding their repertoires for communicating with children who speak little English. Concentrating most of the students in a single school makes it possible for them to visit each other's classrooms easily and thereby to survey the variety of special programs and approaches represented at the school site. Opportunities for program faculty to meet with the school faculty to share expertise are also provided.[2] The student teaching journals now focus on multicultural education issues, which are also raised more often in the student teaching seminar. Although additional topics are introduced in seminar, topics that were emphasized in the first year, such as classroom management and parental involvement, continue to be discussed.

[2]This collaboration was fostered through the efforts of Della Peretti, who coordinates our student teaching placements. Dr. Peretti plays a key role in preparing our students to meet the educational needs of the diversity of children in California.

Master's project. During the spring semester all students complete a master's project on some aspect of developmental teaching. Many combine curriculum development and a pilot study to investigate dilemmas involved in implementing a developmental approach to teaching such as respecting the creativity involved in invented spelling while also establishing conditions for spelling skills to be acquired. In mathematics education a parallel issue is whether instruction that is not based on paper-and-pencil exercises can produce measurable mathematical understandings. Current interests include the value of writing across the curriculum, peer interactions as a resource for learning, and resolving educational problems encountered in highly diverse classrooms. In terms of academic achievement, the master's project represents a culmination of lessons learned about applying developmental theory and research to teaching. In many cases the results are incorporated into the DTE curriculum.

Teacher Development

A variety of outcome measures are required for a comprehensive assessment of the extent to which DTE is attaining its goals as a teacher education program based on developmental-constructivist theory. Relevant outcomes include the teaching practices employed by DTE graduates, the learning achieved by their students, and the recognition they have received from others for the value of their developmental approach to teaching. Central to all such outcomes, however, is the development of the teacher's understanding of pedagogy in developmental-constructivist terms. Advanced understandings of developmental principles are essential if teachers are to make good use of developmental teaching practices and to communicate effectively about teaching with teachers, administrators, and parents.

We have adopted as a working hypothesis the notion that teachers' pedagogical understandings develop through sequential, qualitatively different levels and that it is important for teacher educators to identify the key conceptual differences that distinguish one level of understanding from another within the domain of pedagogy, just as it is important for teachers to understand the conceptual transformations that children go through within each domain of school subject matter. We began our search for levels of pedagogical understanding by examining transcripts from interviews we had conducted during the program's third year of operation with a cross section of beginning student teachers, graduating student teachers, and experienced teachers (Ammon, Hutcheson, & Black, 1985). The interview questions asked teachers to reflect on a number of teaching practices, as well as more general pedagogical issues. In their responses, the teachers expressed a variety of views on children and on the teaching-learning process, and from these we identified conceptual differences in the interview data that might represent different levels of development. This effort led to a preliminary model of teacher development that describes pedagogical thinking at five levels, which are summarized in Table 1 (see also Ammon & Hutcheson, 1989).

According to this model, teachers' pedagogical thinking develops, in general, from associationist and behaviorist conceptions (levels 1 and 2) to constructivist conceptions that are at first quite global (level 3) but eventually become more differentiated and integrated (levels 4 and 5). With regard to the central issue of how teachers bring about learning, for example, the expectation at level 1 is that children will learn if teachers simply show or tell them what they need to know. At level 2, the teacher attempts to remedy the shortcomings of reliance on showing and telling by involving students in the practice of what is to be learned and by providing corrective feedback and reinforcement.

At level 3, the teacher is concerned that a level 2 approach, with its emphasis on closely monitored learning of specific skills, does not necessarily lead to understanding and may even impede it. Thus it becomes the teacher's role to permit the learner to engage in self-directed discovery through interaction with concrete materials that the learner is developmentally ready to understand, that is, to understand "correctly." Developmental readiness is understood only in relatively global terms—for example, in terms of Piaget's general stages.

In contrast, level 4 thinking differentiates between the various domains of knowledge, in which development may occur at somewhat different rates, and it attends to the key conceptual advances that must occur within each domain. The teacher may once again assume a more directive role, except that the teacher now follows the learner's lead and attempts to provoke progressive

thinking on the learner's part. Thus, within a general constructivist orientation, the teacher's role and the learners' development are more highly differentiated.

The differentiations achieved at level 4 provide the foundation for a final, more integrated level of constructivist pedagogical thinking at level 5. Now the teacher appreciates both those aspects of development that are unique to each domain and those that cut across domains, such as logical operations, that have a potentially wide range of application. From this perspective, the idea of an integrated curriculum becomes a functional concept, as an approach to instruction with mutual support for the development of understandings in different domains and as a way of assessing the learner's capabilities across domains.

To date, our strategy for validating and further elaborating these developmental levels of pedagogical thinking has been to carry out a series of small-scale longitudinal studies of DTE students and graduates, based on interview data or on weekly journal writings that all student teachers produce while in the program. For example, two separate analyses of interviews with small groups of students when they entered and graduated from DTE have suggested that most students begin the program with a predominance of their thinking at levels 1 and 2 and leave it with a predominance at levels 3 and 4 (Ammon et al., 1985; Levin & Ammon, in press). An analysis of journal writings from two students who went from level 2 in their entering interviews to level 4 at graduation has shown that each went through a period in midprogram when level 3 predominated, consistent with the hypothesis that the levels constitute a developmental sequence (Hutcheson & Ammon, 1986).

Follow-up interviews with four DTE graduates in their third year of public school teaching have produced evidence of further development in their pedagogical thinking after graduation from the program (Levin & Ammon, in press). This finding suggests that these DTE graduates began their teaching careers with sufficient understanding of, and commitment to, the developmental-constructivist perspective to pursue it further, even while working in an educational system that has been described as resulting in the "washout" of preservice teacher education (Zeichner & Tabachnick, 1981). Informal classroom observations on these graduates indicated that their teaching practices were generaly consistent with a developmental-constructivist perspective.

A more formal observational study of some other DTE graduates has provided similar evidence. Kroll and Black (in press) identified a number of teaching methods that are consistent with developmental theory and research and then incorporated them into the Developmental

Table 1
Development of Teachers' Conceptions of Teaching and Learning

Goals of instruction	Requirements for learning	Nature of teaching
1. A large store of facts and procedures	1. Be able and receptive	1. Telling and showing
2. Essential skills for attaining and using facts and procedures	2. Practice new skills, having first acquired prerequisite skills	2. Giving students practice, with corrective feedback and positive reinforcement
3. Correct understandings of concepts underlying facts, procedures, and skills in a subject	3. Manipulate and explore relevant aspects of reality, having reached the required developmental stage	3. Giving students opportunities to explore and manipulate developmentally appropriate materials
4. Improved conceptual understandings	4. Use best thinking to construct understandings consistent with present level of development	4. Engaging students in thought-provoking activities and guiding their thinking toward better understandings
5. Ways of thinking that can lead to better understandings	5. Reflect on general characteristics of best current thinking	5. Helping students examine their own thinking

Teacher Observation Instrument (DTOI). Methods that matched a *developmental-constructivist* principle emphasized active involvement with curriculum, rather than memorization, and a *recursive* learning cycle. *Social construction of knowledge* was demonstrated by activities such as peer conferencing and collaborative problem-solving groups. *Differentiation and integration of knowledge within and between domains* was represented by activities such as differentiating the composing and editing process in writing and integrating reading and writing. Recognizing the *interactional nature of learning and instruction* was represented by the orchestration of lessons that adequately addressed individual differences in achievement.

Some pronounced differences were revealed when the teaching practices of three DTE graduates were compared with three traditionally trained teachers, matched for grade level, who were identified as excellent teachers by their principals. In their general orientation to teaching, DTE teachers used more small-group than whole-class instruction and more heterogeneous than homogeneous grouping, offered children more choices in grouping and in the content of the lessons, and more frequently provided their students with reasons for engaging in particular lessons. In developing literacy, DTE graduates gave more emphasis to writing to read and reading to write and integrated a whole-language and literature-based approach to reading. They emphasized communication of meaning as a source of skill acquisition more, and they used peer as well as teacher conferencing much more frequently for developing and editing written products.

In comparison with the traditional teachers, DTE graduates were distinguished through their use of hands-on science and manipulative-based mathematics instruction while subordinating texts to a supplemental role in the teacher-organized curriculum. They deemphasized science as a reading activity and emphasized science as observation, experimentation, and communication. In mathematics they emphasized mental mathematics, problem solving, and estimation in contrast to the traditional teachers who emphasized memorization of facts and algorithms.

In the interview portion of the study the DTE graduates expressed more confidence in what they were doing, explaining their methods in terms of their understandings of the implications of developmental theory and research. Taken together, these results again contradict the common finding that graduates of teacher education programs quickly forget or abandon what they have been taught under the pressures of real-world teaching situations. The DTE teacher whose practices were most consistent with developmental principles taught in a school that would be considered most difficult by standard criteria. This is not to claim that we have resolved all of the problems associated with teaching in urban classrooms. Not all of our graduates working in such settings are as successful, and one important area of continuing research is establishing the extent to which a developmental-constructivist approach to teaching is valuable in all educational settings. We also acknowledge the need for more controlled comparisons of programs that take into account the possibility of confounding variables such as the length of the program and the entering ability and motivation of the students.

Discussion

We have sought to demonstrate that a developmental-constructivist perspective on learning is perhaps uniquely suited to serve as core knowledge for elementary teaching because it is comprehensive enough to guide elementary school pedagogy and teacher education. In addition, our developmental approach provides a way to conceive of teacher development that empowers teachers, because the model places the teacher at the center of the teaching-learning process. This view of the teacher as curriculum developer and orchestrator of learning is particularly important today because of the current call for teachers to increase students' educational achievement and to meet the educational needs of an increasingly diverse population of students. These expectations cannot be fulfilled merely by raising educational standards and requiring teachers to administer increasingly complex curricula developed out of context. Therefore, we have attempted to summarize the kinds of knowledge teachers need to master if they are to function as true professionals who understand children and subject matter goals and how to relate one to the other in the context of their own classrooms.

Goals remain to be achieved. We have described our nascent efforts to integrate a developmental perspective with multicultural education. In this area we are further along in affecting practice than in constructing theory in that DTE students and graduates are finding ways to

pursue a developmental approach in culturally diverse settings. Similarly, we have applied developmental principles more extensively to some subjects than to others. When considering peer interaction as a source of new knowledge and development, we noted that questions remain about the generalizability of such an approach to all students and all curricula. The same question needs to be answered with regard to developmental teaching generally. We need studies that compare the success of students in classrooms where developmental teaching predominates with those where other approaches are emphasized. We would welcome the opportunity to collaborate with other teacher educators in solving the problems inherent in such research.

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