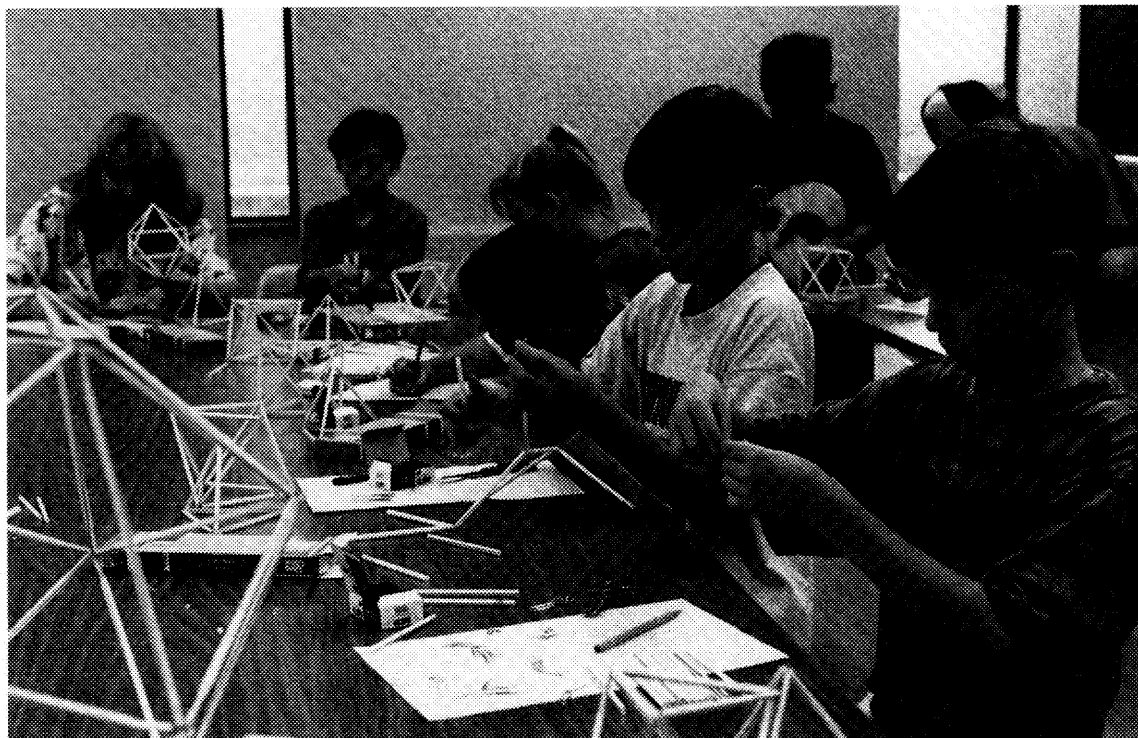




WCER Highlights

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Geometry engages young students



The geometry curriculum Lehrer and Jacobson are developing with the help of elementary teachers grows out of children's knowledge and activities, including drawing pictures and manipulating three-dimensional objects.

Seven-year-old Jamal heads out for school on Monday morning. Making his way down the street, he turns right at the corner, proceeds one block, and turns right again. Turning corners and walking in straight lines reminds Jamal of drawing rectangles, just as his group does in his geometry class.

Geometry? In second grade?

Children this age are capable of understanding basic principles of geometry, and it's about time schools gave them the opportunity, says Richard Lehrer, Professor of Educational Psychology at UW-Madison. Lehrer and his team, working with elementary level teachers, are developing instructional materials and studying ensuing patterns of spatial reasoning in young children.

Lehrer expects that including geometry and spatial reasoning in the K-12 curriculum will have a profound effect on the way children think. Children participating in a pilot study Lehrer conducted began to realize that some geometry problems had more than one method of solution, signalling that they really understood the principles underlying the problems.

WCER Highlights



FALL 1994
Vol. 6, No. 4

ESL students
included in
mainstream
classrooms

Teachers
prepare for
diversity

In many countries K-12 classrooms include geometry as a matter of course. In The Netherlands, for example, primary-grade children work with geometry tasks that mimic events in the real world. They enjoy activities at their desks such as drawing and measuring, and they occasionally get out of the classroom to locate and orient objects and measure angles. In most U.S. classrooms, however, students study little geometry until high school, and then they experience geometry as a single course that remains isolated from the content of other mathematics courses, such as algebra. Lehrer and other advocates of reform believe that geometry should be integrated into K-12 mathematics courses because of its usefulness in modeling problems, and because visual reasoning plays an important part in mathematical and scientific work.

Lehrer and project assistant Cathy Jacobson hope that their project, when complete, will provide ways for teachers across the U.S. to introduce students to geometry at a much earlier age than is typically the case. Classroom teachers are helping with this project because they see the potential for the new methods. They help Lehrer and Jacobson to describe the ways children think about geometrical shapes and to incorporate that knowledge into new curricula. "Students perform better when classroom activities relate to, and build on, experiences they have every day, such as walking to a friend's house," says Jacobson. "So we're asking, 'What kinds of experiences do children have that we can use in geometry?'"

Jamal's teacher uses his morning hike to school as the basis for introducing concepts of line and

angle. To draw or measure a rectangle, for example, Jamal's teacher asks him to begin at a point, "walk" in a straight line, and "turn" a series of corners.

The way children think

The Cognitively Guided Instruction approach to teaching geometry begins with learning what young students already know about shape and pattern (see sidebar, page 3). Lehrer and Jacobson show some awareness of how angles work in plane figures. When primary-grade students had difficulty displaying any knowledge about angles when

given paper-and-pencil tasks, researchers showed them three-dimensional models made of hinges, wires, straws, and tinker toys, then asked them to construct similar objects. While the students worked with the materials, researchers observed their strategies and videotaped their solution attempts. Although they had difficulty talking about angles, students often acted in ways that suggested more competence than tradition would allow. (Commonly received wisdom says that young students don't appreciate distinctions at this level of detail, but instead acquire their conceptions about angles in a "global" or "visual" manner.) Researchers then shared what they had learned with teachers, who used the knowledge to redesign their instruction.

Lehrer and Jacobson began their study two years ago with first-, second-, and third-grade students. The curriculum they are developing with the help of elementary teachers grows out of children's knowledge and activities. Drawing three-dimensional figures, for example, builds on children's rich history of drawing before they enter school. Learning about direction and mapping large-scale spaces grows out of more elementary experiences of finding one's way in the neighborhood. Activities involving three-dimensional shapes grow out of children's enjoyment of playing with blocks and other building materials: Students take apart and put together brightly colored polyhedrons, design quilts, and plan gardens. The curriculum's "measurement" component grows out of, and unifies, all these activities.

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Understanding measurement

When educators design learning environments with children's thinking in mind, Lehrer's study shows, children learn geometry in principle with more depth of understanding. In one activity, for example, students design and determine the area of

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DRAWING TO SCALE

In a problem involving drawing to scale, a teacher presented her students a picture of an adult hippo drawn inside a coordinate grid. She asked them to draw a "baby" hippo inside a scaled-down grid. As the teacher watched their progress, she noted several strategies that ranged from artistic attempts to that did not follow any of the grid scaffolding, to partial-grid work in which only tails and feet were coordinated with the grid squares.

The students shared their work and discussed how best to draw the "baby" hippo so that it looked like a smaller version of the adult. The teacher obtained data about how each of her students approached the problem. Based on these data, she designed a set of activities in which the scale of each of the axes differed.



a quilt. While engaged in design activities such as these, students have to invent their own theories, develop their own strategies, and produce their own notations. "You could consider inventing your own way of measuring the area of a quilt an example of inefficient learning," Lehrer points out, "but you could also consider it as necessary for developing an understanding of the concept of area before they use conventional means, like square inches." Second-graders participating in the new curriculum developed more sophisticated understandings of shape and measure than many of the older children and even adults.

Some people fear that, by focusing on space and shape rather than on addition and subtraction, we're slighting the development of students' knowledge of number, says Jacobson. "But this geometry curriculum engages students in measurement, and their knowledge of number is comparable to that of students whose teachers emphasize number."

The children participating in the study were able to reason about appropriate units of measurement when they were working on problems about length, angle, and area. They could solve area problems involving regular and irregular figures. Jacobson says she was delighted to find that some students were not satisfied just to know the answer to the problem—they wanted to know *how* to reach the answer.

Teachers' professional development

Elementary teachers generally don't teach geometry, so teachers participating in this project have been learning about lines, angles, and area while



Lehrer and Jacobson have seen some fairly dramatic changes, not only in teachers' thinking about geometry, but also in their teaching practices.

WHAT IS CGI?

Lehrer and Jacobson use the principles of Cognitively Guided Instruction (CGI). Developed at WCER by UW-Madison Professors Elizabeth Fennema and Thomas Carpenter, CGI helps teachers tailor their instruction to each class by building on the math knowledge their students already have. This process makes it easier for children to make the connections they're expected to.

CGI classrooms emphasize problem-solving tasks, rather than rote drill. They also emphasize communication between teacher and children and among children rather than work in isolation. In effect, CGI teachers create learning environments in which children actively construct their own knowledge. This contrasts with classrooms in which children are often passive recipients of knowledge from textbooks or teachers. CGI teachers want students to learn with real understanding, rather than by merely memorizing mathematical rituals.

they're learning about students' learning. Lehrer and Jacobson have seen some fairly dramatic changes, not only in teachers' thinking about geometry, but also in their teaching practices.

- At the beginning of the study, participating teachers generally considered geometry and spatial reasoning less important than number skills. Their idea of an appropriate geometry task reflected traditional textbook exercises. After workshops and classroom experience with the CGI geometry curriculum, teachers used more problems involving geometry and spatial visualization.
- Student thinking became a more prominent concern of teachers, who used their growing understanding of children's thinking about geometry to make instructional decisions—for example, when to allow for more student discussion or to pose other kinds of problems.
- Teachers began to see themselves as researchers who could document their students' thinking about geometry and who could design activities that would make students' thinking more apparent. When teachers become less reliant on mass-produced curricula they can tailor materials to the needs of their own classrooms. Jacobson and Lehrer hope that these teachers will be able to use their new skills and knowledge in their daily instruction.

For more information about the CGI geometry project, contact Lehrer or Jacobson at WCER, 1025 W. Johnson St., Madison, WI 53706, (608) 263-4295.

ESL students included in mainstream classrooms

On a bright autumn morning, two dozen elementary teachers meet at school district headquarters in La Crosse, Wisconsin. La Crosse is home to a growing number of Hmong families who are relatively new to this country. Many of the Hmong parents speak little or no English, making it difficult for them to help their children adapt quickly to American schools. These teachers meet today to learn more about helping Hmong and other English-as-a-second-language (ESL) students to function in mainstream classrooms.

Their workshop leader, Paoze Thao, is a training and research specialist from the Multifunctional Resource Center for Bilingual Education, University of Wisconsin-Madison. A native of Laos, Thao speaks Hmong fluently.

The morning's busy agenda includes discussions and lively demonstrations of effective methods that research has shown to be effective in working with ESL students. Being located in WCER's research environment provides MRC staff with access to the newest research, and shows MRC's commitment to sharing the best and latest information with teachers, school district staff, and parents.

During the workshop, Thao introduces a language-teaching strategy that involves modeling and repetition. It's called Total Physical Response (TPR) (Jackson, Price, and Padover, *Beginning English Through Action*, 1981). A teacher using TPR gives a command to the students while modeling the appropriate action; students begin to understand the concept and then act it out. They eventually play the role of teacher and instruct other students. At more advanced levels of TPR, teachers

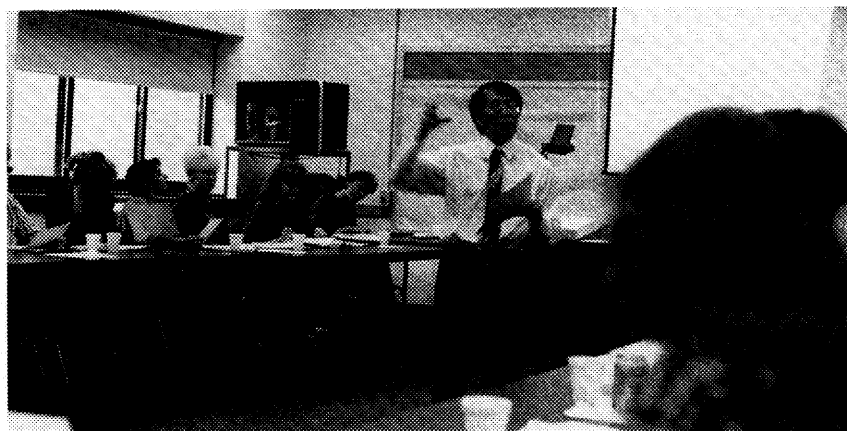
model a statement and ask students to change the verb tense.

Another successful strategy, the Language Experience Approach, teaches reading skills through physical activities. The teacher and students engage in a class project or field trip, then collaboratively create a reading text in the classroom, using the students' own vocabulary, language patterns, and background of experiences (Carol N. Dixon and Denise Nessel, *Language Experience Approach to Reading (and Writing): LEA for ESL*, 1983). Students collectively dictate a story to the teacher, who constructs the basic reading text and gives copies to the students. Students then read the story several times until it has become familiar, learning individual story words and reinforcing other reading skills. To give workshop participants an idea for teaching a unit on circulation of the blood, Thao asks each teacher to stand and put on a small paper sign labeled "left ventricle," "right lung," or "red blood cell." The "blood cells" teachers walk around the room and pass by the "arteries" teachers, the "ventricles" teachers, the aorta, lungs, and so forth. The workshop goes quickly. Judging from the amount of conversation and laughter, the teachers have enjoyed themselves as they have learned.

Parental involvement in schools

During this visit to La Crosse, Thao conducts three workshops within a 24-hour period. Just the night before, he led a two-hour meeting with some of La Crosse's Hmong parents, giving them important information about American schools, and how they differ from the schools the parents knew in Laos. Hmong parents respect teachers as professionals and they hesitate to involve themselves in their children's schooling. Thao must explain to these parents that American schools encourage parents to become involved in their children's schooling. He tells them how, despite their lack of fluency in English, they can support their children's learning at home by showing interest in their children's school work, limiting television watching, and taking them to local places of interest such as the public library or a museum.

As Thao guides parents through the expectations of the American school system, he cites current research that shows how a child's academic achievement can be enhanced through parental involvement. Parents can communicate with school staff, volunteer at the school, and participate in governance and advocacy activities such as



MRC training and research specialist Paoze Thao introduces workshop participants to language teaching strategies including Total Physical Response and the Language Experience Approach.



a parent advisory council, for example (*Fostering Home-School Cooperation: Involving Language Minority Families as Partners in Education*, Emma Violand-Sanchez, Christine P. Sutton, Herbert W. Ware; National Clearinghouse for Bilingual Education, Summer 1991).

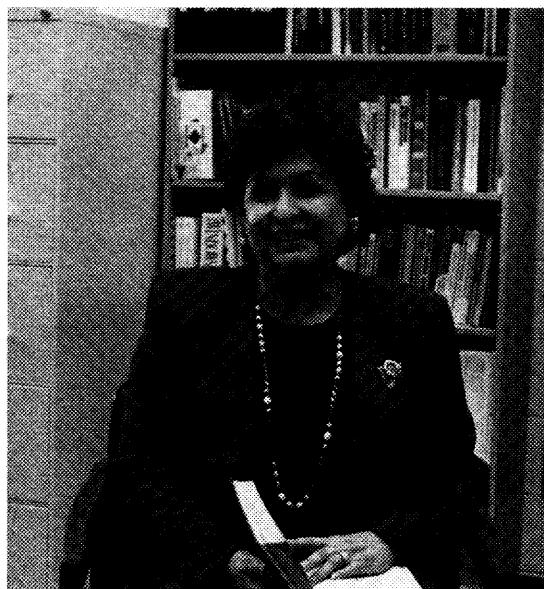
The Hmong parents attending Thao's evening presentation seem pleased to hear him addressing them in their native language. A spirited question-and-answer period follows his presentation, and he later engages parents in one-on-one chats. The following afternoon, Thao will meet with a dozen high school teachers. He will explain why Hmong (and other ESL) students seem to be able to use English informally among peers but have difficulty using English in subject areas in the classroom.

Schools modify instructional programs

Thao's home base, the MRC, is one of sixteen such centers operated in the nation under contract with the U.S. Department of Education's Office of Bilingual Education and Minority Languages Affairs (OBEMLA). Each MRC helps classroom teachers work more effectively with ESL and limited-English-proficient students. The MRC at UW-Madison also provides training and technical assistance to state educational agencies and institutions of higher learning. Operating since October 1986, the MRC at UW-Madison provides services in the six-state region known as Service Area 6, which includes Wisconsin, Iowa, Michigan, Minnesota, North Dakota, and South Dakota.

Students in these six Midwestern states collectively speak more than 86 languages, with a core of 13 representing the majority—Arabic, Chaldean, Chinese, Hmong, Lao, Khmer, Spanish, Thai, Vietnamese, Ojibwa, Lakota, Dakota, and Sioux. As is true throughout the United States, increasing numbers of limited-English-proficient students from Eastern Europe and Southeast Asia are entering schools throughout the Midwest. Schools and districts are struggling to modify their instructional programs to succeed with these students and their families.

MRC Director Minerva Coyne says that there's an ongoing need for basic teacher training and technical assistance, not only because of the influx of students, but also because of staff turnover at schools and in bilingual programs. MRC's training and research specialists address this continuing need by spending lots of time on the road. When several training sessions are scheduled back-to-back in neighboring school districts, a trainer can be away from home for a week at a time. Over the past year, MRC staff have logged



MRC Director Minerva Coyne says that most of the content-area training topics focus on English language arts or on specific instructional techniques suitable for developing academic competence.

more than 16,000 hours leading workshops and providing technical assistance to educators in the Upper Midwest. During the fiscal year ending September 1994, MRC staff provided 1,436 instances of technical assistance and 408 training workshops. Workshop audiences as a whole generally include about 60% teachers, 20% administrators, 12% paraprofessionals, and 8% parents and community members.

Coyne says that more than half of the content-area training topics focus on English language arts or on specific instructional techniques suitable for developing academic competence among limited-English-proficient students. The remaining topics cover culture, counseling, staff development techniques, and integrating educational technology such as computers and video conferencing.

The teachers attending Thao's workshops are eager to gather as much information as they can in the brief time available; their Hmong students need their help now. Thao brings home the urgency of the students' need with a bit of personal experience. "Twenty years ago I studied English in hopes that I might be able to use it some day," he tells the teachers. "But when you help your Hmong students with English this morning, they will be able to use it this afternoon."

For more information, contact the MRC at 1025 W. Johnson St., Suite 770, Madison, WI 53706, (608) 263-4220.

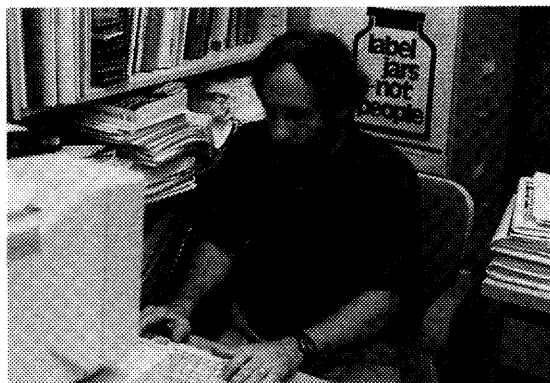
Teachers prepare for diversity

Classrooms in the U.S. will see an increasing proportion of children of color during the next century, yet the teaching force will increasingly represent the white middle class. Some prospective teachers, however, are taking the initiative to better understand and reach students from nonwhite families. They're going to live in the students' neighborhoods and communities while they do their student teaching.

For some, this means packing up belongings and flying to the American Southwest to live on the Navajo reservation. Others head out to regions of Alaska so remote that no roads have been built. Some trade dorm life for a residency in a multiethnic neighborhood on the North Side of Chicago.

UW-Madison Education Professor Ken Zeichner and Michigan State University Education Professor Susan Melnick say that "cultural immersion" programs are doing a good job of preparing prospective teachers for the diversity of students they will find in their classrooms. Their study of these programs and their graduates is part of a larger study called Preparing Teachers for Diversity, which receives funding from the Office of Educational Research and Improvement, U.S. Department of Education, through a subcontract with Michigan State University's National Center for Research on Teacher Learning. Three community immersion programs, designed to enable prospective teachers to recognize these resources, impress Zeichner and Melnick as outstanding.

- Indiana University's American Indian Project requires students to engage in an intensive year-long study of Native American culture, including visits by Native Americans. Following the



Zeichner says that without more interaction between teachers and the communities they serve, poor students and students of color will continue to be ill-served and underserved by schools.

year of study, student teachers move to a reservation, where they live in a dormitory. During the day, they teach, and every night they participate in students' study periods and direct recreational activities. Residents of the reservation invite them to social events such as chapter house meetings, dances, and weddings. As teachers develop friendships with community residents, they gain insights into the community and learn to integrate culturally relevant practice into the classroom. (See one teacher's report, at right.)

- The University of Alaska-Fairbanks' "Teachers for Alaska" Program prepares students to work with Alaskan Native students in remote villages. The year-long intensive experience allows student teachers to live and teach in rural areas where village elders introduce prospective teachers to traditional ways of living. Some students last year accompanied community residents to a statewide convention of the Alaskan Federation of Natives.
- The Urban Education Program of the Associated Colleges of the Midwest prepares students to work in urban schools serving the many different ethnocultural communities in Chicago. Prospective teachers live in a former convent in a multiracial and economically diverse community on Chicago's North Side, where they participate in structured activities that take them into the city's ethnic neighborhoods. They experience everyday urban activities such as getting around on the elevated train, or "El," visiting the Mexican Fine Arts Center Museum, or talking to people who rely on public assistance. These activities help student teachers learn about the cultural resources that can be incorporated into the school program.

Zeichner and Melnick have been unable to find evidence in professional literature of any long-term effect of immersion strategies on teachers and their teaching practices. To address this, they are interviewing graduates of each of the programs in hopes of providing information about the effectiveness of particular strategies to educate teachers for diversity.

Students bring resources

Many teacher education programs, and teachers themselves, consider students from nonwhite families as suffering from various cultural "deficits," but Zeichner and Melnick emphasize that teachers should think of these students as bringing



resources, not deficits, to the classroom. Becoming knowledgeable about students' families and communities helps make teachers aware of these resources.

Community residence experiences help prospective teachers to feel more comfortable dealing with different kinds of students. As they live in their students' home environments, teachers learn to avoid and overcome stereotypes they may have. Their future students, in turn, benefit from teachers' understanding of their families and cultures. Good instruction bridges the world of the classroom with the world of students' homes, making schoolwork more relevant to students' lives.

"Some beginning teachers assume that some kids simply can't learn, or that some parents don't care about their children's welfare," he says. And research has determined that, even under the best of circumstances, teacher education is a weak intervention. Zeichner cites studies by the University of Wisconsin-Milwaukee's Martin Haberman that argue that typical teacher education students who are young and culturally encapsulated are not developmentally ready to make the kinds of adjustments needed for successful cross-cultural teaching.

Becoming an effective teacher requires deep-level changes in beliefs and assumptions, Zeichner says. His work draws on a rich fund of research and experience he has developed with colleagues at the University of Wisconsin-Madison (Professors Carl Grant, Mary Louise Gomez, Robert Tabachnick, and Walter Secada, among others). "We're asking

our prospective teachers to make changes that can't be achieved through mere coursework. And we teacher educators are responsible for addressing these shortcomings." Without more interaction between teachers and the communities they serve, Zeichner says, poor students and students of color will continue to be ill-served and underserved by schools. These students will feel unwelcome in classrooms.

It's not enough to put prospective teachers in culturally diverse schools, according to Zeichner, because often these schools stand as fortresses within their communities, and little or no interaction occurs between the teaching staff and the students' parents and neighborhoods. Making classroom instruction meaningful to the students requires bridging the gap between the school and the

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Teaching on the Navajo reservation

By Susan Lilly

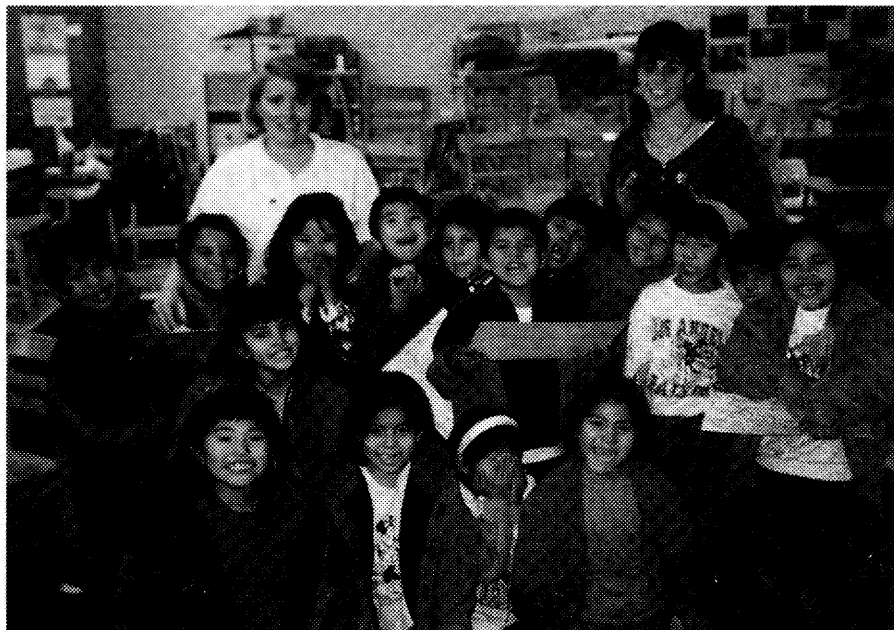
Getting to know my students' families changed how I taught things. I think that's how it should be everywhere. The more you learn about the family and the way they do things at home, the easier it is to teach the students the way they're used to being taught. For example, I didn't know that some of the kids in my kindergarten class spoke only Navajo at home. It was real hard for them to come in the morning and have to go from Navajo to English and back and forth. So I would try to do as much as I could in Navajo even if it was just the days of the week and months of the year.

I also visited their homes. I saw how many kids were around the house, how much of the extended family was living with the kids. They would introduce me to their families and each kid would have something they'd want to show us at home. Most of the parents were really receptive. Back in the classroom, rather than saying, "Did Mom help you with this," or "Did Dad say you could do that?" I could say, "Oh, your Uncle Joe was there. Did he talk with you about this at all? Did you ask him about this kind of thing?" and they'd know that I was making the effort.

The more I got involved in the community, the more it made me realize that these students bring much to the classroom. It really helps me to be a more effective teacher when I can relate things to what I knew the students were thinking.

Learning about my students' home environment has done wonders. It's made me see things through other people's eyes. I take more time to sit and say, "Why are they doing it this way, or why are they thinking this way?" It made me much more patient, because I had to do a lot more waiting, listening, and learning, rather than the "go get 'em" thing that I'm used to doing. There were times when I'd just have to sit back and watch, and let the kids do their thing.

Now I know so much more about not only a specific culture but likenesses and differences just with anybody. I have had a lot of diverse experiences that have made me ready for anything. If I happen to get a job where kids are easy to teach, then I'll be flying through it and can do more things. I think the more experiences you have the better off you are.



Susan Lilly (right) lived and taught on the Navajo reservation for a year.



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WCER Highlights is published four times a year by the Wisconsin Center for Education Research, School of Education, University of Wisconsin-Madison. WCER is funded through a variety of federal, state and private sources, including the U.S. Department of Education and UW-Madison. The opinions expressed in this publication do not necessarily reflect the position, policy, or endorsement of the funding agencies. Fourth-class, bulk-rate postage is paid at UW-Madison, Madison, WI. Send changes of address to WCER, UW-Madison School of Education, 1025 West Johnson Street, Madison, Wisconsin 53706 or call (608) 263-4200. Include the address label from this issue.

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ISSN 1073-1822
Vol. 6, No. 4
Fall 1994

Diversity

continued from page 7

students' homes. Unfortunately, most teacher education programs fail to recognize the importance of community, Zeichner says, and few programs put teachers in contact with parents to hear what they think about school and what they expect for the education of their children.

Zeichner notes a certain cultural insularity not only among student teachers, but also among teacher education faculty at most of the 1,200 institutions that prepare teachers in the U.S. A 1992 study of the first 59 institutions that sought national accreditation for their teacher education programs under the new 1987 standards revealed that only eight, or 14 percent, were in full compliance with the minimum multicultural education requirements for teacher education programs.

"Everybody knows we're not doing an adequate job of preparing teachers to teach all kids to high standards," Zeich-

ner continues. "We need to make a more concentrated effort to achieve this by changing the curriculum and instruction, and changing the way prospective teachers are selected." He insists that merely learning "cultural sensitivity" isn't enough. "Teachers need to translate that sensitivity into culturally relevant practice in the classroom. Those are separate issues."

For more information about the study, "Preparing Teachers for Diversity," contact Zeichner at WCER, 1025 W. Johnson St., Madison, WI 53706, or call (608) 263-5547 or 263-4651.

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