Conventional professional development has not substantially improved teaching, say WCER researchers Fred Newmann and Bruce King, because it violates a number of key conditions for teacher learning.

Recent research finds that teacher learning is most likely to occur when teachers can concentrate on instruction and student outcomes in the specific contexts in which they teach. Yet professional development often presents information that teachers see as irrelevant to student learning in their specific school settings. Teachers often don’t learn and apply what professional development programs offer.

But improving teachers’ knowledge, skills, and dispositions through professional development is a critical step in improving student achievement, say Newmann and King. Teacher learning is most likely when teachers

1. are given sustained opportunities to study, experiment with, and receive helpful advice on specific innovations. Yet most professional development activities entail brief workshops, conferences, or courses that make no provision for followup and long-term feedback.

2. collaborate with professional peers, both within and outside of their schools, and when they gain further expertise through access to external researchers.

Teachers’ individual knowledge, skills, and dispositions must be put to use in an organized, collective enterprise.
Student learning, teacher learning, and mentoring

Undergraduate mathematics and science education is critically important because it shapes attitudes toward science and influences career trajectories. In this issue of Highlights Professor Arthur Ellis of the National Institute for Science Education examines the profound ways technology is altering what can be taught in college mathematics and science courses and how it is taught.

Elementary and middle school science teachers have little research at their disposal to help them orchestrate instruction over years of schooling toward the long-term development of core thematic ideas. But Education Professors Richard Lehrer and Leona Schauble are working with local teachers to design better classroom instruction that promotes the development of students’ understanding of the models and central conceptual structures.

Education Professor Fred Newmann has found that improving teachers’ knowledge, skills, and dispositions through professional development is a critical step in improving student achievement. He has found that teacher learning is most likely to occur when teachers can concentrate on instruction and student outcomes in the specific contexts in which they teach.

This issue also features student mentorship here at WCER. With funding from the U.S. Education Department’s Office of Special Education and Rehabilitative Services, some of our graduate students codirect research projects with faculty mentors. Professors Thomas Kratochwill, Stephen Elliott, and Jeffery Braden are helping several graduate students propose, direct, and report on research projects. We hear from these mentors and some of their students about how this valuable experience is helping them prepare for their careers.

Mentorship is one of the reasons the UW–Madison School of Education consistently ranks so highly in national rankings by U.S. News & World Report and others. We are proud to be part of that tradition.

For more information, visit the WCER Web site at www.wcer.wisc.edu.

Andy Porter

Newmann and King say that learning by individual teachers would be enhanced if professional development were more consistent with these principles. Yet an approach to professional development that focuses only on the learning of individual teachers would still be insufficient to advance student achievement across a substantial proportion of schools.

Teacher success in boosting student achievement depends on the teachers’ ability to implement knowledge and skills within a particular school. But each school contains a unique mix of teachers and students with varying competencies and attitudes and a unique set of social, cultural, and political conditions, all of which influence what teachers do with students.

While individual teacher learning is the foundation of improved classroom practice, teachers must also learn to exercise their individual knowledge, skills, and dispositions to advance the collective work of the school under a set of unique conditions. The design of professional development itself should be grounded in a conception of how schools as organizations affect teachers’ learning, teachers’ practice, and student achievement.

Three dimensions of school capacity

Student learning and the quality of instruction depend on a variety of human, social, technical, and structural resources. Newmann and King say that viewing school capacity as the key to improved instruction offers a way of understanding how a long list of otherwise discrete factors affect instruction. They define school capacity through three dimensions that seem especially susceptible to improvement through professional development.

1. Teachers’ knowledge, skills, and disposition. School capacity includes the knowledge, skills, and dispositions of individual staff members. Staff members must be professionally competent in instruction and assessment appropriate to the curriculum for their students, and they must hold high expectations for achievement.

2. Professional community. Teachers’ individual knowledge, skills, and dispositions must be put to use in an organized, collective enterprise. A vision for social resource development among staff members can be summarized as the development of a schoolwide professional community. A strong professional community consists of (1) clear shared goals for student learning, (2) collaboration and collective responsibility among staff members, (3) reflective professional inquiry by staff members, and (4) opportunities for staff members to influence the school’s activities and policies.

3. when teachers have influence over the substance and process of professional development. Influence over the course of professional development increases teachers’ opportunity to connect it to specific conditions of their schools and facilitates a sense of ownership. Yet conventional professional development is often dictated by school, district, or state authorities without significant input from teachers.
Technology is redefining undergraduate mathematical and physical sciences (MPS) instruction. Developments including digital libraries, sensors, databases, and distance learning are reshaping the tools and the boundaries of undergraduate mathematics and science education.

“Our objectives are to promote science literacy and lifelong learning and to develop a diverse, skilled technical workforce,” says UW–Madison Professor Arthur Ellis. Ellis is Meloche-Bascom Professor of chemistry and leads the National Science Foundation-funded National Institute for Science Education (NISE) College Level One efforts to reform MPS education at the university level.

Undergraduate MPS education is critically important because it shapes attitudes toward science and influences career trajectories, Ellis says. “Without question, technology is profoundly altering what we can teach in college MPS courses and how we can teach it,” he says. Not only is technology a rapidly moving target, but its introduction into undergraduate MPS classrooms and laboratories involves a complex interplay of technological, pedagogical, political, and economic issues.

To provide a “snapshot in time” of the use of technology in college MPS courses, Ellis helped organize a 1999 workshop held at National Science Foundation headquarters in Washington, DC. The workshop defined a vision for the appropriate role of technology in these courses and developed recommendations for how to achieve this vision.

A snapshot of technology-enriched education

Student-centered learning is enhanced by new forms of technology-equipped classrooms and laboratories. For example, students and instructors can use technology to assess student learning on-line through customized instructional software. Technology permits state-of-the-art research instrumentation and tools maintained at one location to be shared across the nation for use in classes and for original student research. MPS instructors and their students collaborate in coursework and in collecting, analyzing, and sharing data across disciplinary, institutional, and national boundaries using technology.

However, Ellis says, enthusiasm for these powerful new technologies is tempered with concern over their effectiveness and cost. Evidence from cognitive and behavioral sciences suggests that students often do not learn from technologies as well as MPS instructors believe they do. There are indications that many students do not want to use available technologies or may use them inappropriate.

A vision for undergraduate MPS education

Undergraduate MPS education should have the same vitality as that of MPS research, Ellis says. An “integrated research” model for undergraduate MPS education would use technology as the research enterprise uses it — as part of continuous experimentation to identify better ways to create and communicate MPS knowledge and methods.

To support this vision, academic culture must

► reward the scholarship associated with creating and implementing effective technology-enriched MPS undergraduate education,

► recognize the importance of multidisciplinary approaches to MPS education,

► support mechanisms for continuous professional development of current and future MPS teachers throughout the educational system, and

► promote efforts to share MPS knowledge with society as a whole.

Recommendations

► Foster an “integrated research” model for undergraduate MPS education. The MPS community should couple research and technological advances more tightly to its educational missions. These advances create an opportunity to update the curriculum continuously, keeping it perennially fresh and exciting. Technology should be used to expand research experiences so that, ideally, all undergraduates develop an understanding of MPS research methods and tools.

► Broaden MPS academic scholarship to include the scholarship of teaching. In partnership with campus administrators, MPS faculty should take the lead in creating and implementing technology-enriched education. Campus administrators and senior faculty can create a culture that encourages faculty to bring appropriate technologies into their courses by publicizing successful technology-enriched courses, by presenting meaningful examples of how well they work, by providing the resources and training to implement these changes, and by valuing these contributions as

continued on page 8

Ellis
C
directing a federally funded research pro-
ject is one of the most valuable experiences
a graduate student could have. Rather than
having to wait until the sheepskin is in hand and a
faculty job has begun on a new campus, the student
can gain “first time” experience in acquiring federal
funding while still working on the dissertation.

An upcoming issue of WCER Highlights will dis-
cuss mentorship programs at UW–Madison funded
by the Spencer Foundation through its Research
Training program. This issue discusses how faculty
help students acquire and manage projects funded
through the U.S. Education Department's Office of
Special Education and Rehabilitative Services.
Graduate students working with faculty mentors
Thomas R. Kratochwill, Stephen Elliott, and Jeffery
Braden propose, direct, and, finally, report on their
own research projects. In this story we hear from
these mentors and some of their students about
how this valuable experience is helping them pre-
pare for their careers.

From the mentors’ perspective

“I see the research process as one of the richest,
most interactive forms of mentorship possible,”
says Stephen Elliott, WCER’s associate director
and a professor of School Psychology. “The stu-
dent’s research process begins with discussions
about a topic or issue. Then the student writes a
proposal, develops the human subject protocol and
the budget. Data collection, data analysis, report writing, presenta-
tions at conferences, and publication of the findings are all part of
the process,” he says. “This process allows for the integration of many
skills learned in our school psychology training program, requires per-
sonal interactions, and offers hundreds of opportunities to influence
the development of a young researcher.

“Managing a grant through
WCER is also part of the mentoring
— perhaps spoiling — experience
for young investigators,” he continues. “Given the performance expec-
tations and the support staff to facilitate the accomplishment of the
grant work, novice researchers are provided an outstanding, successful model of what it takes to
conduct and manage externally funded projects. In addition, they are afforded access to cutting-edge
technology and staff to enhance their research and communication

Elliott continues, “Success breeds success. When one or two stu-
dents are successful in submitting grant propos-
als and receiving support for their research, other
students take notice. It’s common for our first-
year students to now talk about developing a mas-
ter’s thesis that will lead to a grant proposal, that
in turn will lead to a dissertation. That is exactly
what we have hoped would happen.”

Thomas R. Kratochwill also is a WCER
researcher and professor of School Psychology. He
directs the UW–Madison School Psychology pro-
gram and its Psychoeducational Clinic. “The tran-
sition a student makes from a novice to an experi-
enced investigator is gradual,” he says. To learn
from a faculty mentor, the student must be
involved in projects. The modeling influence of
being involved in a project and seeing the day-to-
today operations and processes that go into design,
implementation, and outcome evaluation of various
projects is critically important. Then students must
have an opportunity to take leadership on projects
themselves. “Availability of the faculty mentor dur-
ing this process is important,” Kratochwill says,
because ongoing recommendations are needed. As
students develop greater and greater autonomy,
you eventually suggest their own projects,
develop them, and carry out the entire research
process — with little structure and support from
the mentor. This process usually takes several
years, but it’s necessary for students as they seek to
become independent researchers.

“The faculty mentor is always available, yet as
the student researcher becomes more independent,
their questions and issues are raised. The
kinds of questions asked change. The question
and answer process is reciprocal: Faculty members
learn from the issues that students bring to them
and vice versa.

“Mentorship is actually a way of professional
being,” Kratochwill says. “I find mentorship one of the most critical roles that a faculty member can
engage in. Mentorship is rewarding to the degree
that I can see tremendous academic and intellec-
tual growth in the students. It’s gratifying to see students complete projects, make independent contributions in a research context, and then go to major universities and continue the line of investigation. Ultimately, these research projects will provide important directions for professionals, parents, teachers, and others who work with children in educational environments.”

Jeffery Braden is a WCER researcher and professor of School Psychology. “The School Psychology program here is well positioned to nurture student researchers,” he continues. “The program is ranked first nationally by U.S. News & World Report. The program receives 6 to 10 student admission applications for each open position. We have the luxury of being selective. All faculty are engaged in research and can model research for students. Tom Kratochwill and Steve Elliott are highly visible and involved with WCER.

Students’ careers at UW-Madison’s School Psychology program follow a graduated process that develops steadily, Braden says. Students move from a clinical practicum in their second year, to a field practicum in their third year, and on to internship in their fifth year. Usually, their fourth year is devoted to research; most of the students who write competitive research proposals do so in their fourth year. Consequently, they often spend their internship year working full time providing school psychology services in a genuine setting and working on funded research for their dissertations. This blend of research and professional practice is the goal of the program, which seeks to have all of its graduates become scientist-scholar-practitioners.

The success rate for program students getting their proposals funded is nearly 100%, and Braden believes this is due to a couple of things. “The quality of the mentorship here is high, and WCER provides great institutional resources. It provides a business office, professional editor, computer and multimedia support, and — most importantly — a community of scholars. Second, there’s a great deal of variability in quality among student proposals coming from various graduate schools. I believe ours are consistently good.

“Today’s School Psychology graduates face a good job market,” Braden says.

The program in School Psychology at the University of Wisconsin-Madison prepares students to become research professors and professional psychologists who use knowledge of the behavioral sciences in ways that enhance the learning and adjustment of both normal and exceptional children, their families, and their teachers. Students develop competencies necessary for functioning in settings such as schools and community agencies and competencies for research positions in institutions of higher education.

From the students’ perspective

Student investigator Karen Beavers has been working with Kratochwill and Braden to compare alternative assessment technologies to enhance treatment utility in instructional consultation problem solving. She recently successfully defended her dissertation. Her study compared two treatment methods for children experiencing behavioral difficulties.

Beavers became involved in Kratochwill’s and Braden’s research project during her first semester in school psychology. Her project addresses methods of assessing students with disabilities to determine whether their educational needs can be met within the general education classroom. Beavers moved to Nashville, Tenn., in 1998 to participate in Metro-Nashville Public Schools’ school psychology internship program. With her experience with Kratochwill

Notes

1. Elliott’s most recent work has focused on the assessment of children’s social skills and related problem behaviors and the development of alternative assessment methods for evaluating academic performance.
2. Kratochwill’s interests include child psychopathology, consultation, applied research, and single-case research design. Particular interests include the application of mediator-based (parent and teacher) treatments in schools for the prevention and treatment of childhood problems and training psychologists in consultation and therapy.
3. Braden’s interests include deafness, assessment, research methods, and prevention/promotion in public schools. His goal as a mentor is to enhance students’ ability to perform research first as students, then as professionals.
and Braden in submitting their original proposal in Madison, she was able to prepare the dissertation project to be reviewed by local school systems in Nashville. The study was funded by the Office of Special Education and Rehabilitative Services, U.S. Department of Education, under its student-initiated research program. This program supports student-initiated research projects and is intended to develop research skills in postsecondary students.

“Since then,” Beavers says, “I’ve been balancing the tasks of completing the written portion of the project and preparing it for defense with my work as a first-year Metropolitan Nashville school psychologist. Tom [Kratochwill] and Jeff [Braden] have continued providing encouragement and assistance in completing the project. I look forward to collaborating with Tom and Jeff on submitting the final product to OSERS.”

Student investigator Angela Eke works with Kratochwill and Psychiatry Professor Hugh Johnston to examine the effects of a new treatment approach to selective mutism (SM) in children. This disorder is characterized by lack of speech in specific social situations, especially the school setting, where speech is expected. Many school mental health professionals are not familiar with its diagnosis and treatment. As a result, children with SM may progress through school without receiving treatment. Lack of treatment may adversely affect their participation in many academic and social activities. Her project, like Beavers’s, was funded through the student-initiated research program of the U.S. Department of Education’s Office of Special Education and Rehabilitative Services. “Having the grant and working with Steve has been a very valuable experience,” she says.

“Steve is a wonderful mentor and has been a great role model throughout my graduate career. He’s provided me with a variety of learning opportunities via the grants and outside projects he is a part of; it’s those types of experiences that make a person’s graduate experience more meaningful and well-rounded.”

Schools and districts are striving to ensure that their students meet educational standards. One way of measuring how students are doing in terms of progress toward established standards involves the use of standardized achievement tests. In order for many students with disabilities to participate in state and/or district assessments they are often provided testing accommodations. The Individuals with Disabilities Education Act (1997) requires that students with disabilities be included in state/district assessments to the maximum extent possible, and that students with disabilities be provided testing accommodations when needed to ensure participation.

We need accurate information about student skills so that educational policies and practices can be developed to best help all students meet high educational standards.

“Codirecting the project has helped in a variety of ways. This leadership role forced me to make sure things were in place so the project would function smoothly and follow the timeline. It has allowed me to gain skills in working with a team of people (both the research team at the university and the educators in the schools who volunteer to participate).”
Model-based reasoning in science

Science literacy involves coming to understand the central themes of science in a deep way. However, most science instruction, particularly in the early grades, is devoted to short-term study of a set of unrelated topics, like "the rainforest" or "rocks and minerals."

There is little research to guide educators in the task of orchestrating instruction over years of schooling toward the long-term development of core thematic ideas. But UW–Madison Education Professors Richard Lehrer and Leona Schauble are working with local classroom teachers to design better classroom instruction. Their method promotes the development of students' understanding of the models and central conceptual structures within three central strands in national science standards as detailed by organizations like the National Research Council and the American Association for the Advancement of Science: growth and diversity, animal and human behavior, and structure and form.

Lehrer, Schauble, and their classroom colleagues study the conceptual development of students as they move across elementary and middle school grades of instruction designed coherently and cumulatively around the three themes. Schauble says, "We chose these three strands because they afford easy points of access to primary-grade children, yet they provide sufficient 'lift' so that older students will be challenged."

Schauble and Lehrer have developed a cumulative approach to science instruction and learning which emphasizes model-based reasoning as the most promising route toward learning in the themes outlined in the standards. "Models are central to the everyday work of scientists but are nearly invisible in school science," Lehrer says.

In one classroom children were provided with materials from a hardware store and asked to construct a device that "works the way your elbow does." Through practice and experiment students learn to build models that not only "look like" elbows but "work like" elbows. Physical models of elbows can then lead to graphical and functional descriptions of the relationships between the position of a load and the point of attachment of the tendon. Students can model elbows as third-class levers.

With classroom teachers, Lehrer and Schauble are putting in place these forms of instruction and, over a three-year period, studying transitions in student thinking and learning. The knowledge obtained from these studies should inform researchers and teachers about the feasibility of particular forms of data modeling to support scientific reasoning. This research is funded by the National Science Foundation.

For more information see http://www.wcer.wisc.edu/projects/math_science/modeling_nature.htm.

Professional development

continued from page 2

3. Program coherence. A school's instructional capacity is enhanced when its programs for student and staff learning are coherent, focused on clear learning goals, and sustained over a period of time. For example, one elementary school coordinated instructional improvement around the introduction of technology. With the addition of substantial equipment supported by professional development, the teachers helped students to use email, web page design, teleconferencing, and word processing to improve their written and oral communication skills. A faculty committee developed a plan to coordinate ongoing support for the diverse new technological resources. In contrast, other schools frequently adopt innovations without a central focus or pursue innovations for short periods of time. Such patterns of unconnected, short-term innovations are unlikely to improve instructional quality.

Whether a school leans more toward "traditional" or "authentic" forms of student achievement, high capacity requires strong individual staff competence directed toward focused and sustained collective purposes and supported through reflective collaboration and empowerment of the full staff.

Newmann says, "Whether our notion of school capacity is the most powerful way to explain differences in schools' average student achievement requires further empirical study. But this conception of how schools contribute to student achievement implies that professional development should attempt to address all aspects of school capacity."

This article was adapted from "Will Teacher Learning Advance School Goals?" originally published in the Phi Delta Kappan, April 2000. The article illustrates the three dimensions of school capacity with examples from research on professional development in nine urban elementary schools. This research was funded by the Office of Educational Research and Improvement, U.S. Department of Education, the John D. and Catherine T. MacArthur Foundation, the Spencer Foundation, and W C E R.
Education technology

continued from page 3

essential to the academic mission of the institution.

- **Support teacher professional development.** Partnerships of the broad MPS community with K–12 teachers and teacher education programs should be supported, as they provide exciting opportunities for teacher professional development, including the preparation of new instructional materials for the K–12 curriculum based on MPS research and technologies. College MPS instructors need to communicate to MPS majors that K–12 teaching is a valued career choice, and they should work with teacher education programs to prepare students for teaching MPS subjects effectively, using appropriate technology.

- **Strengthen links to the workplace and community.** The MPS community should work with employers to obtain continuous reports on how well their students have been educated in the MPS disciplines and to inform efforts to incorporate technology into MPS undergraduate instruction.

- **Treat all students as partners, ensuring equity and access.** The ability to learn through technology and to use technology is now a core competency. In partnership with the K–12 community, institutions have the responsibility to ensure that all students have the technological foundation to learn in their restructured, technology-inclusive curricula. Women and students of color, who have historically been underrepresented in the MPS disciplines, are especially at risk in that technology may create new barriers to their participation.

- **Invest wisely in technology.** Technology provides almost unlimited choices for investing in undergraduate MPS education. There are many opportunities for partnerships through which funds can be leveraged. Given the high cost associated with many technologies, it is imperative that information about what is and what is not effective be shared quickly and widely so that our limited resources can be used prudently.

For more information, visit the NISE College Level One website, www.wcer.wisc.edu/niseResearch_Programs.asp