WCER Highlights

WISCONSIN CENTER FOR EDUCATION RESEARCH • SCHOOL OF EDUCATION • UNIVERSITY OF WISCONSIN–MADISON

Videotaped lessons enhance analytical ability

JEFF MILLER

The STEP Web guides users' movements via Web links and navigational strategies.

The STEP (Secondary Teacher Education Project) Web is an innovative learning environment on the World Wide Web that supports case-based instruction for teacher education. Created by UW–Madison education professor Sharon Derry and colleagues, STEP Web resources aim to help future teachers acquire

- a scientific language for thinking about how students learn and develop within disciplines;
- instructional strategies and tools for helping students learn with understanding; and
- flexible transfer—the ability to combine, adapt, and apply the knowledge and tools acquired through STEP and other teacher education courses to classroom teaching.

A recent evaluation study produced statistical evidence of significant growth in students' ability and propensity to activate and combine concepts from the learning sciences in the analysis of videotaped lessons.

An undergraduate teacher education course, based on approaches and materials from the STEP Web, is being offered at the University of Wisconsin–Madison. The course centers around in-depth discussion and learning from videotaped classroom lessons. The resources include:

- stories of lessons, and of student learning and development resulting from lessons, in actual classrooms. These cases include:

WCER Highlights

Winter 2000–2001
Vol. 12, No. 4

From the Director


JEFF MILLER

NISE inspires new lines of research

At the end of five years, WCER's National Institute for Science Education (NISE) has contributed a wide range of accomplishments to mathematics and science education, particularly in the areas of professional development, college level learning and teaching, and evaluation of systemic reform.

In this issue of *Highlights* you will find an overview of NISE accomplishments and read about new lines of research it has generated. For example, a program of embedded research in the Milwaukee Public Schools, headed by Norman Webb and Bill Clune, began as part of the NISE with funding from the National Science Foundation, and has continued with funding from private foundations. Another outgrowth of NISE work is Sharon Derry's STEP Web that delivers high quality teacher education online and solves problems of access to the community of practice and higher education.

Another national center housed within WCER is the National Center on Improving Student Learning and Achievement in Mathematics and Science. This issue also features Adam Gamoran's work on learning communities and self-sustaining change.

For more information about recent research findings visit our web site at *www.wcer.wisc.edu*.

Andy Porter


Derry

- edited video of the classroom plus additional materials that supply information about context.
- instructional problems and projects that make use of cases. They are designed to promote in-depth analysis and, through such analysis, development of knowledge about how to support student growth through instruction.
- a network of case-related links to Web pages and other resources discussing core concepts from cognitive psychology and other learning sciences
- access to expert case analyses and live human expertise (currently under development)
- links to online conferences and case discussions (currently under development)
- links to additional tools and resources that teachers can use to help them adapt and implement ideas acquired from study of cases.

The STEP project was originally developed within the WCER's National Institute for Science Education and funded by the National Science Foundation. Funding now continues from the Joyce Foundation.

Preservice teachers are encouraged to learn so they can later adapt and apply the principles and resources acquired through STEP Web to the design of their own lessons. Research has shown that this type of transfer is difficult to achieve. Derry's premise is that high-level transfer of professional teaching knowledge and skill can be attained through an approach to web-based instructional design based on Cognitive Flexibility Theory (CFT).

CFT holds that the goals of advanced knowledge acquisition in ill-structured domains (such as Web sites) must include flexible and adaptive knowledge transfer. In knowledge transfer, students assemble an appropriate set of ideas as a basis for creating unique models of real-world problem situations. This goal can be accomplished with instructional techniques that require students to re-examine the same domain concepts on multiple occasions in the context of multiple real-world cases and problems. CFT suggests that instruction with hypertext, including the World Wide Web, has potential to convey knowledge complexity and promote cognitive flexibility.

STEP Web instruction

The instructional strategies involving use of a CFT site influence how students navigate and study the complex conceptual terrain. These strategies must encourage students to construct multiple understandings for cases and use concepts repeatedly in case analysis, in different combinations. The strategies Derry uses to meet these conditions in the STEP Web are case-based and problem-based learning.

In case-based learning (CBL) students learn subject-matter knowledge as they study and analyze cases, often experts' solutions to real-world problems. Problem-based learning (PBL) is a form of facilitated, small-group, student-centered instruction in which learners acquire subject matter by discussing and analyzing case-based problems (e.g., redesign Mr. Smith's algebra lesson) and by conducting research to find material (e.g., psychological concepts and related instructional methods) as required for solving the problems.

Derry says that the two approaches are increasingly popular and frequently combined in instructional settings, both on and off the Web, in professional education as well as K–16 settings. Derry refers to the combined model as case-based/problem-based learning (CBPBL). The STEP site supplies instructions for running CBPBL activities that engage small groups of preservice teachers in dis-

continued on page 5

Embedded research spurs systemwide change

How can a large urban school district advance systemwide change?

In a study of systemic reform in the Milwaukee Public Schools, UW–Madison Professor William Clune and Senior Scientist Norman Webb use an approach they call embedded research.

Embedded research integrates the best of traditional approaches: objectivity and subjectivity, technical assistance and evaluation, and qualitative research and quantitative research.

Embedded research looks at existing elements of the school system from the standpoint of systemic theory, but within the practical constraints of district culture and operations. The desired result is to facilitate district actions toward an improved school system configuration. This research began in WCER's National Institute for Science Education with funding from the National Science Foundation. It continues now with funding from the Joyce Foundation and the Helen Bader Foundation.

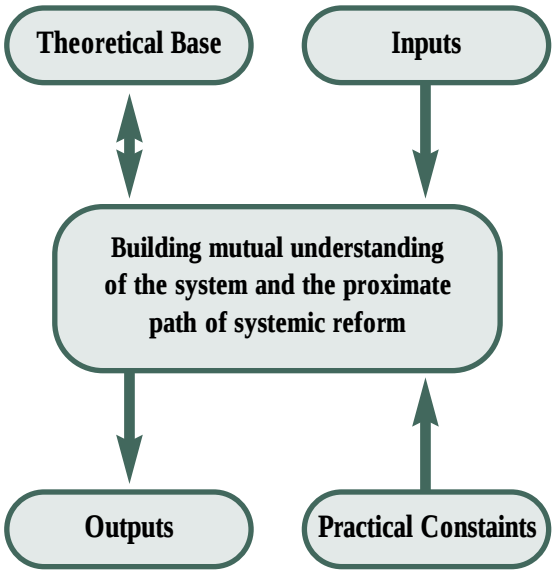
Clune and Webb hope that their findings will serve as a detailed case study of systemic change. The potential to generalize from these findings will depend on the team's success in identifying the path of system change and how the complex array of components common to any large urban district interact to further or retard this change.

Rather than just doing a study *on the district*, Clune and Webb have been working *with the district.* Their purposes and perspectives coincide with design experiment, but separate their work from experimental research.

While Clune and Webb's research shares some aspects of design experiments, their approach differs in the magnitude of the study. Design experiments, as developed by Ann Brown (1992), implemented cognitive learning theory in a classroom setting. In 1998, MPS was the nation's 15th largest school district, with about 100,00 students enrolled in more than 150 schools. Clune says, "For us as researchers to even assume we could implement or design an implementation intervention for the entire Milwaukee school district would simply be naïve."

Clune and Webb's current research focuses on helping the district in three areas.

1. Developing a revised accountability and assessment system that aligns with state and district standards, promotion and graduation requirements, and utilizes a value-added analysis approach.
2. Creating methods by which individual schools can acquire district data and utilize the data for school improvement and increasing student achievement.
3. Collaborating with district staff on developing the proposed system of classroom-based assessments, which will serve as a vital component of a balanced system of assessment of student achievement in an era of increased importance of standardized tests.



Five components of embedded research

Clune has developed a model of embedded research as systemic capacity building. In the forthcoming book, *Theory and Practice of Systemic Reform of Mathematics and Science Education,* he develops a model with five components: a theoretical base, inputs, building understanding, outputs, and practical feasibility (see illustration).

"Our embedded research with Milwaukee Public Schools is guided by a theory of systemic reform," Clune says. "The theory requires the alignment of system components such as standards and assessment. The research also incorporates system and school accountability and assessment principles."

Embedded research, as applied in the Milwaukee Public Schools, gives researchers like Clune and Webb a deeper understanding of the district's operations than if they had remained external observers and data gatherers. Clune says extended interaction with district staff in rethinking the assessment system has helped his team better understand how key ideas are interpreted. Understanding how district staff members use terms, such as 'value-added' and 'multiple measures' as well as 'standards' and 'alignment,' has required numerous conversations. But the effort pays off as researchers come to better understand the underlying district thinking.

continued on page 8

Clune

Webb

Supporting teaching for understanding

Gamoran

Students should learn to reason competently, think constructively, and understand key ideas in mathematics and science. They need to comprehend and manage new information, technologies, and ever more complex problems as these emerge throughout their lifetimes. Successful teachers help students do this by "teaching for understanding" — focusing on student thinking, examining powerful scientific and mathematical ideas, and providing equitable opportunities for learning.

Educators nationwide are striving to improve teaching and learning.

UW–Madison education professor Adam Gamoran says, "Virtually all complex ideas or processes can be understood at a number of levels and in quite different ways, so we characterize understanding as *emerging* or *developing*." Gamoran and colleagues envision changes in teaching as both a response to, and a stimulus for, changes in organizational conditions and professional development.

For professional development to support teaching for understanding, Gamoran says schools must provide better resources to classroom teachers; align purposes, perceptions, and commitments; and sustain change. Gamoran says that supporting teaching for understanding calls on schools to increase their capacity for change. "That requires developing new material resources and human and social resources as well, and allocating resources in ways that support teachers' efforts."

Self-sustaining change

Schools and districts enhance their capacity for change when they promote professional community among teachers, recast administrative roles as facilitative rather than managerial, allocate time for professional development during the school day, and provide materials and resources suitable to new teaching endeavors.

When schools and districts allow new roles to emerge, they foster growth of new human and social resources. In contrast, schools and districts that force new initiatives to conform to existing arrays of resources risk stifling potential change or marginalizing change agents.

Gamoran and colleagues have found many examples of new leadership emerging in the context of professional development among design collaboratives. A design collaborative involves collaboration between two complementary aspects of design and research. Researchers craft and implement the design of a learning environment, then conduct systematic research on the student learning that results from the environment. Design collaboratives aim to design instruction and professional development so that all students (and their teachers) learn with understanding.

At some research sites, Gamoran's research team found these elements of teacher professional communities:

- Teachers exhibit a shared sense of purpose in their attention to student thinking.
- Teachers emphasize student learning rather than administrative details and behavior management.
- Teachers collaborate rather than working in isolation.
- Teachers talk thoughtfully about the nature and practice of teaching.
- Teachers make their own teaching practices public rather than private and confined to the classroom.

Another school presented a contrasting case. There, teachers weren't granted additional released time for professional development, which was instead taken out of the regularly scheduled meeting time. This meant that common planning times could not be used to diffuse ideas from the design collaborative to other teachers in the school, as

occurred at other school sites. Moreover, this school was organized into "families" that cut across subject areas, which made professional collaboration within subject areas difficult to pursue. Finally, teachers in this linguistically diverse school were divided into bilingual and monolingual groups, a split that was not overcome by the design collaborative.

Educators across the nation are striving to improve teaching and learning, often with the help of outside experts such as comprehensive reformers, leaders of change movements, and university-school partnerships. How can schools and districts best support these efforts to improve? For teachers attempting to "teach for understanding," what supports and barriers are presented by their schools and districts? How can the supports be enhanced and the barriers overcome?

For more information contact Gamoran at gamoran@ssc.wisc.edu.

This research is conducted as part of the National Center for Improving Student Learning in Mathematics and Science and is funded by the Office of Educational Research and Improvement, U.S. Department of Education.

Effective Web-based instruction

continued from page 2

cussions, research, and instructional design. This instructional approach is illustrated in the following example.

Case study: Static electricity

In spring semester, 2000, the 55 students enrolled in Derry's educational psychology course were assigned to small groups of 5–7 students. The groups studied together within a CBPBL format. During the semester, each student participated in two different CBPBL groups. Each group was assigned a problem and a case to study. For example, a case assigned to a group of science majors was "Students Get a Charge out of Static Electricity." This case was presented on STEP Web as readings, videos, and inquiry materials.

The case tells the story of an actual science unit in a public school taught by a popular teacher and representing a good case of traditional instruction. The problem was to advise Mr. Johnson (the teacher) on how to improve the unit and to justify the group's redesign in learning-sciences language. Derry expected that students would redesign the lesson, developing a more authentic, inquiry-based approach for the unit.

After studying the case individually on STEP Web, students began their group work in class by discussing the case and identifying things they needed to learn more about in order to solve the redesign problem. Between classes, students researched their learning issues, bringing varied findings to their group discussions.

STEP Web was made available as a primary research tool that could be used either during or outside of class. The links and navigational tools within STEP Web scaffolded students' research while allowing them to pursue interests in depth. By selecting any of the links associated with any segment of the video case, a student could enter the conceptual network in the knowledge web. They could study case-relevant concepts exposing scientific points of view and inviting further exploration of related ideas and idea families. Research beyond the materials in STEP Web was also promoted, since links led to other library and WWW resources. Some students also purchased and used optional textbooks.

The problem required about four weeks to complete. The tutor guided students through class and on-line discussions of their research, during which time they identified positive and negative aspects of the instruction within the case and proposed new instructional solutions. In the third week they posted their redesign with explanations on a Web conference for peer evaluation and consultation with experts, including scientists and educational experts. After revision, a group design report was submitted and evaluated as a course requirement.

Evaluation of STEP Web

The STEP implementation during spring semester, 2000, represented a process of continuous user-centered design. Students provided critiques and suggestions that were used to improve STEP Web throughout the semester. Intensive feedback was first obtained from a small number of students who volunteered to be research subjects, but all students eventually were surveyed to obtain their feedback and satisfaction ratings.

Most students in the UW–Madison course were pleased with the knowledge Web by mid semester, but their comments indicated that further development was needed. Based on students' concerns, there was need to add to and improve resources on STEP Web, improve navigation, and provide instructional supports within the course to speed the process of learning how to use the site.

An analysis of a single CBPBL group demonstrated that students struggled with core concepts from the course and that discussions of cases provided opportunity for learners to socially construct

continued on page 8

NISE completes five years

Mathieu

At the end of five years, the National Institute for Science Education (NISE) has contributed a range of accomplishments to mathematics, science, engineering, and technology education. With funding from the National Science Foundation it has

(a) built working partnerships with states, districts, scientific and education organizations, federal agencies, and foundations;
(b) completed eight books;
(c) published over 100 journal articles, research monographs, and briefs (including an article in the most recent issue of the premier research journal in education, the Review of Educational Research, and another in a special issue of Teachers College Record);
(d) produced 11 Web sites, including the award-winning The Why Files (see http://whyfiles.news.wisc.edu), which gives the science behind the news, now institutionalized in the UW–Madison Graduate School budget; and
(e) conducted five innovative and highly successful forums (and three additional national meetings at the request of NSF).

JEFF MILLER

NISE's College Level One Team has extended its work to address classroom assessments.

One outgrowth of NISE work is Professor Sharon Derry's STEP Web that delivers high quality teacher education online and solves problems of access to the community of practice and higher education (see story, page 1).

NISE research on *professional development in science and mathematics* is a good example of the strength and influence of the Institute's work. Susan Loucks-Horsley's 1994 book, *Designing Professional Development for Teachers in Science and Mathematics*, written with Peter Hewson, Nancy Love, and Kathy Stiles, is a top seller for Corwin Press. It has been published twice in short form by the Eisenhower National Clearinghouse: once with a focus on science and once with a focus on mathematics. Tens of thousands of copies of each short form have been distributed to members of the field. The *NISE Brief* that presents the framework for professional development has been widely copied for use with practitioners in workshops and courses around the country. The work guides the current national evaluation of the Eisenhower Program.

"Clearly," says NISE associate director Robert Mathieu, "the field needed this synthesis and reconceptualization of professional development in mathematics and science and gave it an enthusiastic reception."

A forthcoming NISE book promises to do for *evaluation of systemic reform* what Loucks-Horsley's book has done for professional development. The book by Norman Webb and others not only synthesizes the field, it pushes the field forward by reconceiving the concept of alignment. It does so by showing that current methods of program evaluation are not adequate for coping with the complexities of systemic reform, and by offering alternatives. (Its working title is *Evaluation of Systemic Reform in Mathematics and Science*.)

Another book, by William Clune, Paula White, and others, proposes a theory of systemic reform (working title: *Theory and Practice of Systemic Reform of Mathematics and Science Education*). This volume represents the first empirical tests of validity. "For systemic reform to remain useful," says Clune, "clarity and empirical tests are essential."

NISE's College Level One Team, under Arthur Ellis's leadership, has directed its attention to the synthesis of forefront education research in higher SMET education. The essential results of these syntheses are disseminated to SMET faculty through the CL–1 "Innovations in SMET Education" Web site (*www.wcer.wisc.edu/nise/CL1*) developed by Tony Jacob. Their early work on small-group cooperative learning began with a meta-analysis to see whether a research base existed for this often-promoted teaching strategy. The team identified a large positive effect associated with small-group learning that has caught the attention of college science teachers and higher education administrators across the country. Since then, the CL–1 team has extended its work to address classroom assessments, providing SMET faculty with powerful alternative assessment strategies for use in their instruction). Currently the CL–1 team is addressing the effect of technology on student learning in undergraduate SMET education, led by Susan Millar. Research on undergraduate education and the resulting Web-based tools have been key to NISE's successful involvement of scientists, says NISE Director Andrew Porter.

As the above examples demonstrate, NISE is committed to research that steps back from the field and takes a big-picture view, pulling together what is known in new ways, sometimes leading to reconceptualizations, and always pointing to promising directions for practice and future research.

NISE is equally committed to disseminating its findings. Many resources have been directed toward sharing research results with audiences. One especially effective mechanism has been the series of NISE forums. Under the leadership of Senta Raizen and Ted Britton, the NISE offered its first annual forum in its initial year of funding. The format was to select a rapidly developing area of NISE work, convene 300 or so leading practitioners and researchers in that area, and engage them in dialogue that results in a written statement capturing the current wisdom of the field. These invitational forums proved so successful that others, including NSF, increasingly looked to the NISE to conduct forums on topics they identified or to advise them on how to run similar events of their own. The forum strategy is now widely available through a Corwin Press book, *Designing Successful Meetings and Conferences in Education: Planning, Implementing, and Evaluating* (2000).

JEFF MILLER

NISE findings suggest promising directions for practice and future research.

When NSF's Education and Human Resources Directorate created the NISE in July 1995, it charged its first research center to "address the totality of the education enterprise, to assess its effectiveness and examine what new activities need to be established, what activities are no longer needed, and what new approaches will enhance science education." That work has succeeded, and it continues.

For more information, visit the NISE Web site at *http://www.nise.org*.

WCER HIGHLIGHTS STAFF

Director Andrew Porter
Editor Paul Baker
Editorial Consultant Cathy Loeb
Production Office of University Publications

WCER Highlights is published 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, the National Science Foundation, 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, 1025 West Johnson Street, Madison, WI 53706 or call (608) 263–4200. Include the address label from this issue.

WCER Highlights is available on the Web at *http://www.wcer.wisc.edu.*

ISSN 1073–1822
Vol. 12, No. 4
Winter 2000–2001

Embedded research

continued from page 3

The form the new assessment system will assume and the criteria used for judging graduation and promotion requirements will be important indications of the effect of the embedded research approach in the district. "We do believe district staff members are thinking more deeply about value-added analysis and multiple measures," says fellow researcher Norman Webb, "but other pressures, cost and manageability, may be of greater concern." Despite the limitations imposed by these district realities, the intermediate research goals certainly are being realized: helping the district think systemically through some of its most pressing problems.

Clune and Webb have a multidisciplinary research team, with expertise in law, policy, statistics, psychometrics, evaluation, student assessment, data systems, school improvement, professional development, and special education. Drawing on these multiple perspectives facilitates an objective interaction and feedback between research studies. This collaboration enhances the learning and improves the team's ability to respond to the district and to offer meaningful technical assistance.

For more information contact project researcher Sarah Mason at *samason@facstaff.wisc.edu*.

Web-based instruction

continued from page 5

meanings, share knowledge, negotiate conflicts, and integrate ideas from other courses. Significant shifts in some individuals' conceptual understandings were documented. Lectures in between the class discussions proved to be meaningful for the learners if they discussed concepts or ideas imparted by lecture sessions. These findings suggest that the instructional model as a whole is viable in terms of course goals.

Derry and colleagues are now continuing three specific lines of work:

1. Expanding STEP resources, focusing specifically on the development of new and improved video-based instructional cases
2. Conducting research that will guide design of better instructional cases
3. Building and testing conferencing tools within STEP to support a distributed (distance) form of CBPBL that will permit improved course implementation on a larger scale with fewer human resources. This addition will also provide new users with early guidance in use of STEP Web and will therefore minimize some reported difficulties in learning to use the site effectively.

For more information visit the site at *www.wcer.wisc.edu/STEP*

Wisconsin Center for Education Research
School of Education
University of Wisconsin–Madison
1025 West Johnson Street
Madison, WI 53706

Address correction requested

Nonprofit
Organization
U.S. POSTAGE
PAID
Madison, Wisconsin
Permit No. 658