



WCER Highlights

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NISE project addresses college science teaching and learning



JEFF MILLER

The National Institute for Science Education is identifying more effective ways of meeting college students' needs.

First-year college science, mathematics, engineering, and technology (SMET) courses act as curriculum “pressure points.” Courses that are well designed and well taught give nonmajors the learning skills and appreciation for the subject matter that will serve them well the rest of their lives. They prepare SMET majors for productive careers. Courses that are poorly designed or taught bring disillusionment, causing some students to decide to change educational paths. In short, college SMET courses offer students experiences that will influence the remainder of their college years and perhaps their careers.

Researchers at the National Institute for Science Education (NISE) seek to determine what can be done to help more college students succeed in SMET coursework. Echoing themes from a recent National Science Foundation

report, “Shaping the Future: New Expectations for Undergraduate Education in Science, Mathematics, Engineering, and Technology,” UW–Madison Chemistry Professor Arthur B. Ellis says first-year college SMET courses should provide students with critical thinking skills, SMET literacy, and life-long learning habits. Educators should provide high expectations in a supportive environment. Students should learn to model good practices and learn what scientists and engineers do.

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Director's column

New possibilities for science educators

WCER's National Institute for Science Education has begun its third year. Our researchers continue to develop knowledge to help reform education practice and policy in science, mathematics, engineering and technology (SMET) fields, grades kindergarten through graduate school. In this issue of *Highlights* you'll read about NISE's Policy Analysis of Systemic Reform Team and its guidelines for effective systemic reform, and about NISE's College Level One Team, which reports on developments in SMET teaching and learning at the college level.

A special kind of leadership is required to promote successful reform in any area of education. Leadership at the school level is of particular interest to WCER's Comprehensive Regional Assistance Center. In this issue you'll read about how school leaders embrace and use certain paradoxes as they go about their work.

Teaching and learning present more complex challenges now than in previous generations. WCER's Center on English Learning and Achievement studies the ways in which people become literate. In this issue you'll read about the broader context in which teachers can think about learning and teaching literacy.

On a related note, WCER's Upward Bound program recently honored the first three of its graduates to complete their college degrees. I extend my congratulations to these graduates (see story) and to our Upward Bound staff.

Andy Porter



JEFF MILLER

collaborative instructional methods, has long been practiced in K–12 education. Over the past few years, some of these innovations have been introduced into college-level SMET courses. NISE researchers Leonard Springer, Mary Beth Stanne, and Sam Donovan have analyzed research that contrasts small-group learning with lecture-based instruction in undergraduate SMET courses. Results of their meta-analysis show that small-group learning has large and robust positive effects on academic achievement, attitudes toward learning, and persistence through SMET courses and programs.

To make relevant literature more accessible to scholars and practitioners, researchers James Cooper and Pamela Robinson are preparing an annotated bibliography that encompasses leading references on cooperative learning in postsecondary SMET courses. Their thematic review of the subject includes links to non-SMET courses and to K–12 research in the field.

"Much research identifies reasons why college students don't succeed in college SMET courses," says Team member Aaron Brower. "But much of this work tends to focus on students' personalities (e.g., aptitude or motivation), thereby blaming the victim and legitimizing institutional practices. Or it focuses on environmental factors (e.g., unsupportive academic environment), creating blameless victims." CL–1 research broadens these perspectives by identifying what higher education can do to make instruction more effective.

Better teacher preparation needed

Preservice teachers potentially have an enormous impact on science literacy. They will instruct large numbers of students who are forming their impressions of SMET fields. Yet preservice teachers are exposed to SMET largely through college courses not designed to provide the kinds of tools and perspectives that they will require. The CL–1 Team is identifying and studying innovations that are being implemented in college science and mathematics courses to better serve the needs of this important student audience.

These innovations include a greater emphasis on conceptual understanding and alternative presentations of SMET content that better exemplify how it may be taught to enhance science literacy. The CL–1 Team will be working with the NISE Professional Development Team to analyze the implications of this training for inservice teacher practices.

For more information, visit the NISE Web site at <http://www.wcer.wisc.edu/nise/>.



JEFF MILLER

UW–Madison
Chemistry Professor
Arthur Ellis

Ellis directs NISE's College Level One (CL–1) Team, which is helping the higher education SMET enterprise move toward this vision of student achievement. Much less research has been done on SMET teaching and learning at the college level than on the precollege level, making it an emerging field of research. The Team is developing resources to illuminate key issues in CL–1 SMET courses in ways that will be useful to a broad spectrum of educators.

Effective practices identified

The CL–1 Team is identifying more effective ways of meeting college students' SMET needs. These include improving teacher preparation, creating a more equitable learning environment, and implementing instructional innovations. For example, small-group learning, including cooperative and



Shaping effective systemic reform

Recent efforts to reform science and mathematics education have produced some success. Educators know more than ever about the characteristics of successful reform. But systemwide reform of mathematics and science education has not yet produced the widespread major changes in teaching and learning that lead to corresponding universal changes in student achievement.

UW–Madison Law Professor William Clune and his team at the National Institute for Science Education are developing knowledge about how to improve the effectiveness of systemic reform in mathematics and science education. Clune and the Policy Analysis of Systemic Reform (PASR) Team analyze research about systemic reform and work with representatives of Statewide Systemic Initiatives, Urban Systemic Initiatives, and evaluation personnel from the National Science Foundation. They're addressing the criteria for evaluating systemic reform efforts, and what succeeds and fails.

"The national science and mathematics standards are broad and general," Clune says, "and they have given some broad guidance for reforming science and mathematics education. But," he says, "this same generality stops short of providing a basis for detailed implementation." If there's one big knowledge gap in the area of national standards, Clune says, it's for specific curricula and assessments that fit the standards.

Systemic reform is at the stage of developing a theory of change that links the process of systemic reform to its intended student outcomes. NISE's PASR Team suggests that every strategy should be evaluated according to these seven characteristics:

- ▶ quality and scope of mathematics and science goals;
- ▶ demonstrated emphasis on student achievement and classroom change;
- ▶ institutional leadership for quality implementation (for example, from a university or science "academy");
- ▶ authority over regular budget and operations;
- ▶ sustainability and expandability (for going to scale);



JEFF MILLER

Women and students of color are underrepresented in mathematics and science courses and careers.

- ▶ good data on curriculum, classroom practice, and student achievement; and
- ▶ credibility of plans for equity.

Achievement varies across gender and race

Because women and students of color are underrepresented in mathematics and sciences courses and careers, the PASR Team is working toward ways to achieve racial, ethnic, and gender equity in mathematics and science achievement. Team members William Tate and Alberto Rodriguez, for example, recently explored differences in student achievement on a variety of measures and data sets. They worked with longitudinal measures of achievement that were disaggregated by race, ethnicity, and gender.

Tate and Rodriguez found small differences between genders on science tests, but a substantial difference in favor of males on the mathematics portion of the SAT. This mathematics/gender difference remained constant across ethnic groups. The ethnic groups themselves differed substantially from each other in average scores.

Tate and Rodriguez also found mixed evidence for the proposition that taking similar courses will produce similar results. While taking similar courses did narrow achievement gaps across gen-

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William Clune directs analysis of systemic reform.

Learning to read and to write

A 50-year-old woman remembers first writing in a hospital bed when she was four years old and feeling abandoned.

An 11-year-old boy remembers writing his first story at age five when his family moved to a new neighborhood. He wrote about a pig who was having trouble making friends.

A 60-year-old woman remembers writing her first childhood poem. She was sitting alone on the front steps of her house waiting for her older sister to return home from school.

UW–Madison Professor of English Deborah Brandt has been investigating the ways in which people’s reading and writing skills form and develop. Over the past few years, Brandt has interviewed more than 80 people to determine how ordinary people cope with the rapidly changing conditions of literacy learning. How did they, as students, become literate? How did they use literacy in their roles as students, parents, community members, workers, and public and private citizens?

In her work for the National Research Center on English Learning and Achievement (CELA), Brandt builds on the information she gleaned in interviews with these Wisconsin residents. They represent a cross section of the population in terms of age, race and ethnicity, place of birth, educational level, and occupation. Brandt asked people what they could remember about learning to read

and write. What were the occasions, people, materials, and motivations involved in the processes?

It turns out that, while reading seems to be valued in many families, writing is not. “Parents and teachers send messages about the prestige of reading to children early and often,” Brandt says. “Reading is often incorporated into shared family rituals and is supported independently of school through such avenues as religion, hobbies, and the values of parent-child involvement. But writing is less explicitly taught and publicly valued.” That’s because, Brandt has found, adults’ writing practices are largely embedded in day-to-day work: earning money, paying bills, or maintaining communication with distant family relations. In addition, these activities tend to be taken care of without involving children.

People talking to Brandt tended to remember, and value, their early reading experiences differently than their early writing experiences. Differences especially pertained to the settings in which early reading and writing were remembered to have occurred. For example, people typically remembered their first reading experiences as pleasurable occasions. Reading was often motivated by adults and books. Parents endorsed reading and sometimes organized opportunities for reading. Three quarters of the people Brandt spoke with said that reading and books were actively endorsed

Parents and teachers send messages about the prestige of reading early and often.





in their households. "Many working-class and middle-class parents regarded teaching reading to their children as part of normal parental responsibilities," Brandt says. Her interview subjects usually recalled reading as a clearly demarcated activity. For example, some could recall the names of their first books.

But teaching or encouraging writing was nearly unheard of, beyond showing very young children how to form letters or checking the spelling on homework assignments. People's memories of writing were vague. More often than not they remember instances of writing as "doodling," or "homework," or watching their parents "doing the bills."

"Except for dutiful thank-you notes or letters home from camp that some people recalled being required to write as children, writing does not appear to play a standard role in the activities or rituals of families, especially in the communal way that reading does," Brandt says. "Nor is writing so readily identified as a separate activity. Writing seems to be experienced more as a means to an end, than an end in itself. Parents don't seem to sponsor or endorse writing as broadly, nor does the identity 'writer' seem as available as the identity 'reader.'"

For the most part, the interviews suggest that reading and writing were often linked in school assignments but usually in ways that subordinated writing. Writing seemed to be introduced in order to induce, support, or verify reading.

People's stories suggested that much writing develops in situations and out of psychological motivators that are significantly different from those surrounding reading. "Compared to reading, much early writing is remembered as occurring in lonely or secret circumstances," Brandt says. While the motivations for reading were often adults and books, the motivators for writing were not. Children's impulses to write emerged from their immediate circumstances and feelings. While people tended to remember reading for the sensual and emotional pleasures that it gave, they tended to remember writing for the pain or isolation it was meant to relieve (as illustrated by the three examples at the beginning of this story).

Brandt is completing a book tentatively called "Pursuing Literacy: Writing and Learning to Write in the Twentieth Century." Her recent articles include "Remembering Writing, Remembering Reading," *College Composition and Communication* 45/4, December 1994, and "Accumulating Literacy: Writing and Learning to Write in the Twentieth Century," *College English*, 57/6, October 1995. She is also working with two other CELA researchers who are writing social histories of literacy among Wisconsin's Hmong and Native American communities.

For more information contact Brandt at dlbrandt@facstaff.wisc.edu.



ANANA CHIKASA

Recent college graduates Jonelle Ellis, Angela Cremer, and Adrienne Wiley-Thomas.

Upward Bound honors alums

By providing appropriate kinds of support, WCER's Upward Bound Program is demonstrating that all students can succeed in high school and complete a college education.

A college preparatory program for first-generation, low-income students, WCER's Upward Bound program recently honored the first three of its graduates to complete their college degrees. The graduates are Angela Cremer, Jonelle Ellis, and Adrienne Wiley-Thomas.

Cremer, West High School Class of 1992, has completed a BS degree in Business at UW-Madison. Ellis, West High School Class of 1992, has completed an AA degree in Liberal Arts and an AS degree in Human Services at Minneapolis Community College. Wiley-Thomas, West High School Class of 1993, has completed a BS degree in Communication at Antioch College, Ohio.

They were toasted at a banquet by Upward Bound staff, by students currently enrolled in the Upward Bound Program, and by UW-Madison dignitaries. During the 1997-98 school year, WCER's Upward Bound program serves 27 ninth graders, 14 tenth graders, 8 eleventh graders and 16 twelfth graders.

WCER's Upward Bound program offers students in grades 9 through 12 after-school and summertime academic support, personal counseling, academic and career advising, and study and social skills development. Additional activities include ACT/SAT testing and a family financial aid workshop for the seniors, a National College Fair trip for the juniors, and a career clinic for the sophomores. Freshmen have social development workshops, study skills development, and academic advising. Students remain with the program through their high school graduation.

Over the program's seven years at UW-Madison, 55 students have graduated, 50 of whom have gone on to attend postsecondary schools, including UW-Madison, Washington University-St. Louis, Alverno College-Milwaukee, Macalaster (Minnesota), and Antioch (Ohio), the University of Miami, UW-LaCrosse, UW-Platteville, and Madison Area Technical College.

Effective leaders embrace paradoxes



Effective school leaders infuse a school with passion, purpose, spirit, traditions, and values.

Is your school principal an effective leader or a mere manager?

Or is this question too “either/or”?

Over the years public schools have become highly specialized, extensively regulated, and enormously complex organizations. Principals who act as leaders, rather than as mere managers, are better able to guide their schools.

In his training and research role with WCER's Comprehensive Regional Assistance Center, Region VI, UW–Madison Professor of Educational Administration Kent Peterson focuses on school leadership in the context of education reform. Working with school leaders in general, and principals in particular, Peterson promotes the concept of “bifocal leadership” and the idea that good leadership, by nature, involves many paradoxes and complexities.

Bifocal leaders promote purpose

Schools need principal-managers, who, along with teachers, can see and respond to technical, rational issues. Good principal-managers collaboratively help create direction, order, and stability in order to improve outcomes. But a *leader* goes beyond

technical issues to understand and respond to situations in symbolic ways. “Leaders infuse a school with passion, purpose, spirit, traditions, and values,” Peterson says. Leaders bring out the symbolic, culture-shaping side of the principal's roles. They work with staff and community to shape values, rituals, ceremonies, stories, and other symbolic forms that make work and learning more connected, value-driven, and meaningful.

But rather than seeing management and leadership as polar opposites, Peterson considers them complementary in the work of principals. (Perhaps it is this yin-and-yang relationship that has attracted Asian scholars: The book he co-wrote with Vanderbilt University's Terrence Deal, *The Leadership Paradox*, was recently translated into Japanese.)

“Some principals combine good planning with good culture-building,” Peterson says. “Terry Deal and I call this ability ‘bifocal’ leadership. Principals with ‘bifocal’ vision create both order and meaning. Bifocal principals find a balance between being traditional and innovative, tight and loose, inflexible and creative. They both support change and defend the status quo. They embrace the paradoxes and puzzles of their work. They use these



complexities as the fulcrum for creating new approaches to leadership.”

Schools need more leaders who can embrace and blend both the technical and symbolic sides of their role with confidence and enthusiasm, skill and insight, Peterson says. Not only principals, but also superintendents, school board members, teachers, and other school leaders should be encouraged to *shape* the role that they occupy, rather than passively implement directives from elsewhere. By harmonizing the technical and symbolic aspects of their roles, school leaders can increase their positive influence on students’ learning and development.

Take advantage of paradoxes

Schools across the country are making significant changes in the ways they organize time and teach and assess students. These new demands require new ways of thinking about leadership. Peterson and coauthor Deal suggest that it’s useful to embrace and exploit paradox—a seemingly contradictory situation that runs counter to common sense, but seems actually to be true. By examining, accepting, and understanding the paradoxical nature of leadership, principals and teachers can more deeply engage themselves in reform.

Consider these central paradoxes:

1. People don’t work for rewards: Reward people! Most teachers and administrators, once employed, don’t seek major financial or other types of rewards for their efforts. But they do seek meaning, purpose, and recognition for their commitment, effort, and energy. Schools do not set up reward systems to foster restructuring, but schools that don’t recognize the special contributions of faculty find effort and energy disappearing. Educators don’t work for rewards, but they must be rewarded.
2. Plans must always be revised: Plan carefully! One of the great challenges in schools is planning complex changes. Even the best laid plans must always be revised. Peterson says it’s useful to view careful planning not only as a problem-solving process, but also as a community-building process. Leaders also use planning to communicate symbolically that change and improvement are important, collaborative, and necessary.

3. Allocate resources equally: Distribute resources where they are most needed!

School leaders must constantly deal with trade-offs between equity (allocating the same resources to everyone) and the demand for quality (investing resources where they will do the most good). The goal is to find a widely shared sense of quality-directed equity.

4. Don’t make decisions until you have it all figured out: Act quickly!

Because reform by its nature involves trying new approaches and new techniques, it requires a special kind of timing for decisions. Successful school leaders have learned to live with the challenge of making rational, carefully developed decisions while managing rapid-fire decisions when all the data aren’t in. Living in this paradox requires knowing how to make “reasoned” decisions and knowing how to force the issue when opportunities arise.

By accepting the paradox of change and improvement, Peterson says, school leaders may find their efforts not only more productive, but more fun as well.

For more information, see *The Leadership Paradox: Balancing Logic and Artistry in Schools*, by Terrence E. Deal and Kent D. Peterson, Jossey-Bass, 1994. Peterson also contributes a monthly article on school reform issues to the Comprehensive Center’s Web site at <http://www.wcer.wisc.edu/CCVI>.



Kent Peterson promotes the concept of bifocal leadership.



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Systemic reform

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der and ethnic groups, it did not eliminate the gaps, nor did it occur with sufficient frequency to allow comparisons for many students.

Longitudinal data on student outcomes that's disaggregated by ethnicity, gender, and subject matter is very useful, Clune says. "Systemic reform efforts that don't collect and analyze disaggregated data are ignoring an important tool. At the same time, there's considerable uncertainty about how to use such data," he says. For example, when educators debate about how to make courses in mathematics and science more accessible to a greater number of students, one group recommends extending traditional, college preparatory, academic courses to greater numbers of students. Another group says that courses that emphasize understanding and applications have been much more effective in raising student achievement, for example, the "Chem Com" course in high school.

Clune says that programs meeting equity goals all share these characteristics:

- ▶ good data, analysis, and reporting on differences and trends in achievement;

- ▶ a sound strategy for simultaneously raising standards and increasing access; and
- ▶ an approach to curriculum and teaching that connects with, and engages, particular groups of students.

Breadth of change needed

There are scattered programs that boost student achievement and reduce inequities. The challenge now, Clune says, is to scale up these programs to systemwide proportion. The major reason for limited change observed to date is that most schools and teachers take pieces and parts of reform models and merge them with existing practice. They merely produce a layering of old and new. Research should try to identify any and all policy configurations and sequences that lead to deep and broad systemic change.

For more information, see the NISE Web site at <http://www.wcer.wisc.edu/nise/>.

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