



# WCER Highlights

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## More coursework benefits all students



JEFF MILLER

Despite differences in gender and racial-ethnic heritage, students completing the same number of mathematics courses did not have significant differences in achievement.

**O**ur country's racial and ethnic diversity is greater now than at any previous period in history. It seems to be on course to become progressively more diverse for some time to come.

In 1990, white children made up less than 70% of the total school-age population, down from about 75% in 1980. During the 1980s the number of poor school-age children increased by 6%, from about 7.2 million to 7.6 million. Poor children became more racially and ethnically diverse. While the number of poor Hispanic and Asian children grew by almost 600,000, the number of poor white children declined, and the African-American school-age poverty population remained relatively the same.

What does this mean for educators? It means continuing gaps in student achievement if reform measures are not taken. Between 1980 and 1995 differences in students' mathematics achievement were greater along racial-ethnic, socioeconomic status (SES), and language proficiency lines than across gender lines. Although the differences among the

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From the Director

## More ways to boost student achievement

Large research universities like the University of Wisconsin–Madison are powerhouses of discovery and invention. The results of their research have far reaching implications. But amid all the productive research, undergraduate instruction sometimes receives less attention than it should. Faculty from across UW–Madison are focusing attention back onto teaching and learning by participating in the American Association of Higher Education’s Teaching Initiative. Under the direction of Katherine Sanders, these faculty are supporting each others’ commitment to improving undergraduate teaching through peer review of teaching. Their findings are now available on the World Wide Web.

The Web shows promise as an effective tool for teaching science. Our National Institute for Science Education’s Web site, *The Why Files*, has won many awards for its quality and timeliness. We wanted to know more about the people who use the site, and how they navigate through it. This kind of information can be used to guide the development of our site and other science-related Web sites. In this issue of *Highlights* Sharon Dunwoody and William Eveland share what they found and why it’s significant.

African-American and Hispanic students are still performing at significantly lower levels in mathematics and science than white and Asian students, according to studies of college entrance examinations and Advanced Placement tests. UW–Madison professor William Tate has found that students of every racial-ethnic group and socioeconomic status group benefit from additional mathematics coursework in high school. Differences in gender and in racial-ethnic heritage made little difference in achievement.

UW–Madison Professor Allan Odden proposes linking standards reform to funding policies. He is a strong advocate of giving schools the power to determine how to use the dollars available in the education system. With colleague Carolyn Busch, Odden offers strategies for reducing the nation’s worst fiscal disparities by focusing on the lowest-funded districts.

For more information about these and other WCER projects, visit our Web site at <http://www.wcer.wisc.edu>.

Andy Porter



JEFF MILLER

studies and the results from college admissions examinations and Advanced Placement tests. He tracked the achievement of various student groups defined along lines of race, class, gender, ethnicity, and language proficiency.

Across various assessments (the SAT, ACT, and the National Education Longitudinal Study [NELS]) Tate found a strong relationship between students’ SES and their mathematics achievement. Because poverty is more severely concentrated among African-American and Hispanic students than it is among white students, Tate advocates raising the mathematics achievement of all low-SES students, and especially of low-SES minority students. “These findings suggest the need for an intervention in the two geographic regions with the highest poverty levels,” Tate says, “the urban and rural communities.”

At the same time, Tate found that students of every racial-ethnic group and SES group benefit

**During the 1980s the number of poor school-age children increased by 6%, from about 7.2 million to 7.6 million.**

from additional mathematics coursework in high school. Despite differences in gender and in racial-ethnic heritage, students completing the same number of mathematics courses did not have significant differences in achievement.

Tate advocates using this finding as a policy tool to mandate specific course requirements at the secondary level. To enhance such a policy intervention, elementary level instruction should receive additional support, Tate says, because elementary school mathematics achievement is positively related to secondary school achievement. Mandating more secondary courses should therefore involve systemic efforts to change elementary school mathematics experiences and achievement levels as well.

Tate agrees with Odden and Busch (see story page 6) that equity strategies require fiscal support for adopting and implementing high-level achievement standards for all. “Many school districts simply can’t afford to implement new mathematics standards,” Tate says. “Severe fiscal constraints plague most urban and rural communities.” He found that more than 80 percent of teachers in schools with middle- to upper-SES students received all or most of the materials or resources they requested for instructional purposes. In stark contrast, only 41 percent of teachers in schools with the largest concentrations of low-SES stu-

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scores of students from various races and ethnic groups have slowly narrowed, African-American and Hispanic students still perform at significantly lower levels than white and Asian-American students.

In his role as researcher for the National Institute for Science Education, UW–Madison Education Professor William Tate recently documented changes within and across demographic groups in students’ mathematics achievement during the 1980s and 1990s. Tate reviewed national trend



## The Why Files users match profile

**W**ho uses the World Wide Web? How do they use it?

Knowing the answers to these questions helps Web site designers appeal to specific audiences and to structure their sites to make users' visits most profitable and memorable.

*The Why Files* is the National Institute for Science Education's (NISE) award-winning Web site that communicates science information to the public. Every two weeks, *The Why Files* posts a new science-related feature story package that contains a feature article, a bibliography page, a glossary of terms, a credits page, and a "story map" or index page. About 20,000 individuals access *The Why Files* during each two-week content cycle.

NISE researchers William Eveland and Sharon Dunwoody have studied who visits the site and how visitors make their way through the site's contents. Dunwoody, a UW-Madison professor of journalism and mass communication, and Eveland, an associate researcher, knew that Internet users as a whole are nearly 60 percent male and over two-thirds have attended college. To determine whether *The Why Files* users generally match or diverge from that profile, they conducted two studies. One used survey data from a sample of about 400 *Why Files* users and another used a database of site use, called an audit trail.

What Dunwoody and Eveland learned about *The Why Files* visitors agrees with past evidence from the literature on diffusion of innovations. The data show that users who repeatedly visit tend to be well educated and male—very much like the "typical" Web user, if unlike the "typical" American. Similarly, considering that education is strongly related to the use of popular printed science magazines, and that twice as many men as women read these magazines, it's no surprise that educated men are most likely to be repeat users of *The Why Files*.

The average respondent to Dunwoody and Eveland's user survey was between 36 and 37 years old and a heavy Web user, reporting using the Web on average about once a day in the month before the survey. As expected, repeat users were very interested in science, mathematics, engineering, and technology topics. They rated these subjects around 8.25 on a 1-to-10 scale, with 10 representing "extremely interested."

"As the Web becomes a more democratic place in the future," Dunwoody says, "we'll have a chance to see whether the demographics of *Why Files* users changes, too. If users do become more eclectic, that suggests that the Web may be a good way of getting science information to segments of

the population who don't typically seek science information. If not, that will mean that science sites like *The Why Files* will continue to preach to the converted. Time will tell."

### Choosing among many paths

In addition to showing who uses *The Why Files*, the data show how users maneuver through the site. Each page of a *Why Files* package can be reached from any other page in the package via a navigation bar. Movement between pages is also available



Dunwoody (left) and Eveland are finding how hypermedia documents can promote learning about science.

via in-text links, with the last sentence of each page—a teaser for the next page—always including an in-text link to the next page. In addition, the previous and next pages are accessible through prominent buttons at the bottom of each page.

Most Web sites allow visitors to navigate through them either in linear fashion or randomly, as the spirit moves them. Forward and backward buttons, hypertext links, and colorful images all beckon the visitor to a multitude of informative pages within each site. This flexibility is part of the value the Web offers learners. But the Dunwoody/Eveland study shows that visitors to *The Why Files* site tend to read pages in sequential order, as if they were flipping through a magazine.

Users did not make much use of the site navigation features such as page-turning buttons and page numbers. Instead, visitors tended to read a

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## Peer review supports teaching

**T**hey had to admit it: They were dissatisfied with their methods for reviewing teaching effectiveness. Professors in the UW–Madison chemistry department needed more meaningful teaching reviews.

The department had traditionally employed end-of-semester student questionnaires as the primary measure for evaluating teaching quality. But a group of professors in the department realized that the information gleaned from the questionnaires was proving unsatisfactory. And although the professors regularly discussed their research, there was less opportunity to discuss their teaching accomplishments and their frustrations. Then they discovered a project sponsored by the American Association of Higher Education (AAHE) that aimed to raise the quality and the status of teaching in American colleges and universities.

In 1994, under the leadership of then Associate Vice Chancellor Gary Sandefur, UW–Madison joined a dozen campuses across the country to participate in a national AAHE project to enhance the profile of teaching. Six UW–Madison faculty from chemistry, history, and electrical and computer engineering attended the first AAHE conference. With the support of the Madison administration and their departments, they agreed to explore various aspects

of formative peer review of teaching—helpful, constructive, and nonjudgmental. Other campuses explored the process for summative review—for evaluation, merit, and promotion.

Participants in the pilot departments identified a number of alternative approaches and protocols for peer review of teaching. As a result of some of these efforts, electrical and computer engineering developed a departmental policy about the process for reviewing probationary faculty.

From 1994 to 1996, these faculty continued to design and pilot peer review techniques in their departments, with the intent of helping themselves



UW–Madison Professor of Theatre and Drama Joe Varga (right) makes a point about reviewing a colleague's teaching.

and their colleagues develop new teaching skills or improve their teaching. After this successful first phase of the national project, UW–Madison chose a different approach to help move the conversation across more disciplines and teaching activities.

To this end, Gary Sandefur and his successor, Associate Vice Chancellor Bob Skloot, collaborated with WCER Associate Scientist Katherine Sanders to design a process for involving more disciplines in the conversation. They recruited a diverse group of faculty volunteers to review the literature, talk with experts, and design a tool for UW–Madison instructional staff to help them create their own peer review processes for improving teaching and its assessment.

The UW–Madison project team created its own mission statement:

1. To develop a clear statement of the intents and purposes of the peer review of teaching,
2. To clarify the breadth of teaching activities that peers might review, and
3. To compile a Menu of Options for peer review of teaching. The menu, now available on the World Wide Web (<http://www.wisc.edu/MOO>), includes detailed information about techniques and their effective use and about implementing peer review.

The Menu of Options lists approaches and protocols for peer review of teaching, arranged by purpose or function of the technique, Sanders

### Phase II Project team members at UW–Madison include:

- John Bennet (*Classics*)
- Tom Broman (*History of Science*)
- Michael Chial (*Communicative Disorders*)
- John DeLamater (*Sociology*)
- Pat Farrell (*Mechanical Engineering*)
- Richard Green (*Real Estate*)
- Joe Varga (*Theatre and Drama*)
- Karen Young (*Veterinary School*)



explains. Procedures may be chosen to serve a particular purpose, audience, or stage of career.

The Menu includes both formative and summative information. Formative review refers to information from colleagues collected to contribute to the development of teaching; feedback goes directly to the instructor. Summative review refers to information collected for use in an evaluation or as input to an evaluation. The project's intent is not to define policies, Sanders says, but to help individuals and departments develop a mindful approach to the review of teaching, having considered the multiple purposes and intents of review and the numerous options for achieving a desired outcome.

To gather information for the Web site, the team talked with dozens of people across the UW–Madison campus, asking junior faculty, senior faculty, and department chairs what they wanted to know about peer review of teaching. A list of hundreds of questions was summarized into major themes, which are the basis for the site's structure.

Visitors to the site find information arranged by procedure:

1. How can I develop or improve my teaching?
2. How can I show evidence of my teaching?
3. How do I conduct a review of a colleague's teaching?
4. How do I evaluate evidence provided by peer review of an instructor?
5. How can I help raise the profile of teaching in my department?
6. How do I design a peer review program?

The team is organizing workshops across the campus for UW–Madison faculty and academic staff to use the site and provide suggestions. The team is interviewing volunteer participants from pilot departments to assess how the Web site structure and content served their intended purposes and to evaluate which techniques should be edited, deleted, critiqued, or added.

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

### Other participating universities include:

California,  
Santa Cruz  
Georgia  
Indiana University  
Purdue University at  
Indianapolis  
Kent State  
Michigan  
Nebraska-Lincoln  
North Carolina-  
Charlotte  
Northwestern  
Stanford  
Syracuse  
Temple

## Coursework

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dents received all or most of the instructional materials they requested. In addition, the students whose teachers reported limited materials or resources had lower mathematics achievement than those whose teachers indicated their materials or resources were sufficient.

## Classroom cultures affect student learning

School mathematics instruction traditionally emphasizes whole-class lectures. Teachers offer one method for solving a problem and students listen to the explanation. Following the lecture, students work alone on a large set of problems from a textbook or worksheet. This practice is so regular, Tate says, that it's a cultural artifact—a default cultural policy. The intent of this cultural policy is to prepare students to produce correct answers to narrowly defined problems. This policy often includes a tracking system, with many students of color and of low SES being selected to participate in compensatory mathematics programs. Very often these programs offer mathematics that is disconnected from the learner and devoid of real social context.

Many equity models in mathematics education today borrow from opportunity-to-learn constructs from national and international testing programs. These models frame equity as the overlap of con-

tent taught and content tested. But these models ignore the influence of cultural factors on student learning, Tate says.

Future equity-related policies in mathematics education should begin with recommendations found in the NCTM *Professional Standards for Teaching Mathematics* (1991), which calls for mathematics pedagogy to build on

- a. how students' linguistic, ethnic, racial, gender, and socioeconomic backgrounds influence their learning,
- b. the role of mathematics in society and culture,
- c. the contribution of various cultures to the advancement of mathematics,
- d. the relationship of school mathematics to other subjects, and
- e. the realistic application of mathematics to authentic contexts.

"The importance of the mathematics standards movement for traditionally underserved students is obvious," Tate says. "Previous reform efforts have not met their needs. These efforts have failed to garner the support required for change—specifically the development and implementation of a comprehensive fiscal and cultural policy.

"The challenge is before us."

For more information contact Tate at [wftate@mac.wisc.edu](mailto:wftate@mac.wisc.edu) or (608) 263-5035.

[Adapted from *Journal for Research in Mathematics Education*, December 1997, Vol. 28, No. 6.]



Tate says some models of equity ignore cultural factors in student learning.

## Link funding to standards reform

Although there are many ways to approach education reform, UW–Madison Education Professor Allan Odden likes to focus on the dollars-and-cents side. Schools could teach students to higher standards, Odden says, if schools, rather than districts, had the power to determine how to best use the dollars in the education system.

Odden believes that providing schools their budget in a lump sum—school-based financing—should represent the next major evolution of school finance. Why? Because school-based financing is consistent with standards-based reform initiatives that set clear directions (such as standards and assessments) at the state or district level, and then give schools the responsibility and the authority for meeting student performance objectives. “Ensuring that schools have considerable control over the resources necessary for meeting students’ academic needs is critical to holding schools accountable for educational performance,” Odden says.

Contrary to popular opinion, the education finance system has amassed considerable resources throughout this century. It has gained between 25 percent and 75 percent in real per-pupil terms each decade up through the 1980s. However, despite this increase in resources, the education dollar is neither distributed fairly nor used effectively. Odden and associate Carolyn Busch identified large disparities in education funding within and across states—literally thousands of dollars per pupil.

“There are vast resources available for education,” Odden says, “but in the current system, some students, by accident of their birthplace, get more and others get less, regardless of their individual educational needs. This strategy isn’t the best way to deploy resources so all students can achieve to high and rigorous standards.”

Odden and Busch propose these strategies for reducing the most egregious fiscal disparities, focusing on the lowest-funded districts.

**1. Within states.** In keeping with current state-controlled education finance policy, the first alternative operates state-by-state to solve the school finance dilemma of unequal and inadequate funding. This strategy uses cost-adjusted per-pupil local and state general funding, thus excluding state categorical funding and federal funding. This equal-

ization strategy brings all of the lowest-funded districts up to the funding level of the *state median* within each state. Busch says, “We chose the median because it provides substantial equity for the bottom half and because research in two Midwestern states found that the median was a sufficient amount to teach students to a state achievement standard.”

The total revenues of all districts combined in the 1991–92 school year was \$191 billion. The estimated cost of raising the lowest-funded districts to the state median was \$8.5 billion in 1991–92 dollars, or \$10.9 billion in 1996–97 dollars, which represents a 4.5 percent increase in basic education revenues. This policy would affect 37 percent of all districts across the nation. Thus, a fairly modest increase in funding could help more than a third of the country’s school districts eliminate all of the “savage” fiscal inequalities in the country and provide an adequate amount of funding, at least in some states.

**2. Nationally.** The second alternative extends across state boundaries and addresses the educational system as a nation. Again using cost-adjusted per-pupil local and state general funding, this second equalization strategy brings all of the nation’s lowest funded districts up to the *national median* (see Table 1). This plan is more expensive—costing \$16.6 billion in 1991–92 dollars, or \$22.3 billion in 1996–97 dollars—but even so it reflects a relatively small 9.2 percentage increase in funding and helps almost 33 percent of all school districts across the U.S. The impact of this option would vary dramatically across states. Several states, such as Alabama, Illinois, Kentucky, Mississippi, Oklahoma, and Tennessee, would have revenues increased for more than 90 percent of their students. Other states, such as Alaska, Hawaii, Maryland, and New Jersey, would have revenues hiked for none of their students, and several other states would receive additional revenues for fewer than 10 percent of their students. By focusing on states largely in the South and West, where funding for education is relatively low, the federal government would address the systemwide need for improving educational opportunity and results nationally.

For either alternative, the federal government could play an important role in reducing inequities in education funding, especially for the lowest-spending districts. A modest amount of additional



Odden says school finance must be constructed to support strong educational programs within schools.



**Table 1. Costs of raising districts to the *National Median* of state general plus local revenues per pupil, 1991-92 (in \$ billions)**

	K-12 Districts	High School Districts	Elementary Districts	All Districts Combined
Total Revenues Additional	\$165.642	\$4.826	\$10.368	\$180.836
Revenues to Raise to Median	\$15.300	\$0.509	\$0.751	\$16.560
Percent Revenue Increase	9.24	10.55	7.24	9.16
Total Number of Districts	10,634	559	3,518	14,711
Number of Districts With Revenues Raised	3,953	136	754	4,843
Percent Districts with Revenues Raised	37.17	24.33	21.43	32.92

Source: Analysis of Common Core of Data, 1991–92 (U.S. Bureau of the Census, 1992).

money is needed for about a third of the nation's school districts so that they have a sufficient level of resources. Nevertheless, as the common phrase goes, "Throwing more money at the problem won't fix it."

**3. A new management approach.** Accomplishing the reform goal of teaching nearly all students to high standards requires a doubling or tripling of current student achievement results. Odden concludes that a new management strategy is required to accompany the standard setting, measurement of results, and accountability that are part of standards- and school-based reform. The new management approach would be a performance-based, decentralized system in which schools would be provided substantial authority and autonomy to accomplish results. The state and districts would set goals, standards, and directions, and administer a real accountability system. From research in both education and other settings, Odden and Busch find that providing budget authority to the school is a key element of this new management strategy.

For the majority of states and districts this will require a totally different budgeting system—budgeting dollars to schools in a lump sum rather than providing schools with district-determined resources such as teachers, teacher specialists, instructional aides, etc.

In their new book, *Funding Schools for High Performance Management: School Site-Based Financing*, Odden and Busch discuss how school-based financing has been implemented in charter schools in the U.S. and the policies of the states of Victoria, Australia, and in England, both of which adopted a comprehensive form of school-based financing in the 1990s. Odden and Busch write explicitly about education finance and school-based financing, but their new book is implicitly about the entire education system. In fact, understanding the theme of the book depends on understanding how school finance must be constructed to support strong educational programs within schools.

For more information, contact Odden at [odden@macc.wisc.edu](mailto:odden@macc.wisc.edu) or (608) 263-4260.



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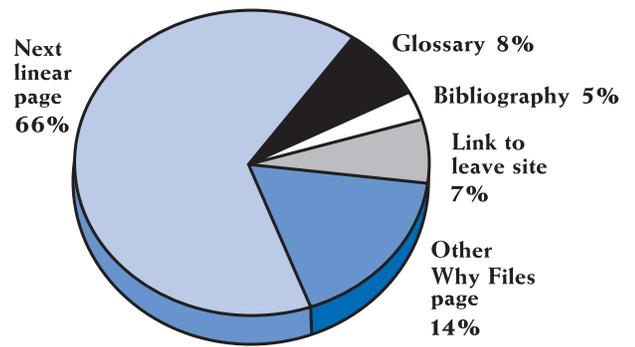
*The Why Files*

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page and then click on a hypertext word or phrase in the story to move on to the next page. Similarly, little use was made of additional information in the glossary and bibliography or of links to other sites on the Web.

“The linear navigation pattern may be a function of several things,” Dunwoody says. “One is that the strong narrative structure of a *Why Files* story is spectacularly successful. Another is that most Web users are recent converts to the Web and may have not yet adopted nonlinear use patterns. Again, looking at navigation patterns over time will tell us if the second reason is at work. The success of a strong narrative could be a good thing, as narratives can enhance learning.”

“*The Why Files* site has the potential to serve as a useful template for future SMET-related sites,” says Eveland. “Our study is too descriptive to provide an answer to the question, ‘Can a Web site such as *The Why Files* help users become more scientifically literate?’ But our study gives us a foundation for designing the research to answer that question.”



Of those users who were on a page in a main feature story package and selected another page to view, about two-thirds selected the next page in that package.

Eveland and Dunwoody are collecting and analyzing data from “think aloud” protocols (individual sessions at a computer in which individuals express their thoughts as they navigate the site) and from detailed interviews of novice and experienced Web users. Results will allow Eveland and Dunwoody to design a series of experiments to better understand what aspects of hypermedia documents will promote learning about science.

For more information contact Dunwoody at [dunwoody@facstaff.wisc.edu](mailto:dunwoody@facstaff.wisc.edu) (608) 263–3389. *The Why Files* can be reached at <http://whyfiles.news.wisc.edu>.

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