Challenges and Opportunities in Math Education Reform

“Mathematics for all” is a goal that has not been realized, despite the attention and efforts of many mathematics educators. The 2008 Trends in International Mathematics and Science Study (TIMSS) showed that mathematics learning opportunities for students in the U.S. are often shallow, compared to many other countries. The curriculum, particularly with the middle grades, is repetitive and lacks depth. And too often assessments do not align with district frameworks and classroom curriculum materials. That means students are either tested on mathematical content they have not had the opportunity to learn, or they are tested on only a small part of what they have learned.

The development of richer, more challenging mathematics classroom environments and learning opportunities requires simultaneous renewal of curriculum, instruction, and assessment.


**Mathematics In Context**

Mathematics in Context (MIC) was developed and later revised at the Wisconsin Center for Education Research under the leadership of Thomas Romberg in collaboration with a group of curriculum designers at the Freudenthal Institute in the Netherlands. MIC embodies the theory of Realistic Mathematics Education (RME) proposed by Hans Freudenthal. Instead of seeing mathematics as subject matter that has to be transmitted, RME stresses the idea of mathematics as a human activity, arising from the reality of students. Education should give students the "guided" opportunity to "re-invent" mathematics by doing it.

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The ITP includes courses in students' disciplines, in education, and in advanced statistics, including courses in experimental design and measurement; a weekly interdisciplinary seminar; certification in a minor in education sciences; a research practicum on randomized trials in education; an intensive internship in randomized field trials; and ongoing experience in faculty-led research projects that address practical problems in education.

Challenges remain Despite the success of these reform mathematics curricula, and of the Show-Me Project, challenges remain. Meyer says these challenges face mathematics teachers, district leaders, teacher educators, and future mathematics curriculum developers over the next decade.

Challenges:

1. Students in many parts of the country have not had the opportunity to learn mathematics using quality standards-based mathematics curricula.
2. The four NSF-funded curricula were developed in response to the 1989 NCTM Standards. At that time, few states and fewer districts had a mathematics curriculum framework. The landscape has changed drastically since: Most states and districts have their own standards or frameworks. Expectations for students vary widely by state and district. Students meeting proficiency standards in one state can be considered below proficient in another. What happens then?
3. Curriculum publishing is a business, and publishers must keep an eye on the bottom line. If a curriculum does not sell, the publisher will not continue to support it. Curriculum developers and publishers need to continue cooperating to ensure the educational and commercial viability of the curriculum materials.
4. Over the course of the 10 years of the Show-Me Project, the four sets of curriculum materials evolved in response to several outside forces. One effect of the standards movement has been to push the first-year algebra course down into the middle school. At issue is agreement about what constitutes a first-year algebra course.

CONCLUSION

The Show-Me Project

Show-Me Project Director for MiC and WCER assistant scientist Margaret Meyer says the project supported change in teachers' practice by targeting curricular change. The project's goals included:

(a) supporting the awareness, examination, and implementation of comprehensive standards-based middle school mathematics curricula;
(b) designing, developing, and supporting professional development opportunities for middle grade teachers and administrators;
(c) providing communication networks for middle school teachers and their district teams who implement new curricular and instructional techniques designed to advance student understanding and achievement in mathematics; and
(d) providing information and professional development to mathematics educators and mathematicians in higher education who prepare future generations of middle grades mathematics teachers.

Changes in teaching

Since the publication of the 1989 NCTM Standards and the publication of the standards-based curricula, it has been clear that teachers are being asked to teach different mathematics (than they learned) in different ways (than they were taught) and this demands significant professional development.

For example, when using MiC, teachers encounter a tension between (a) teaching for student recall of common algorithms and (b) teaching for student understanding through guided reinvention using mathematical models (including, for example, percent bars and ratio tables). The teacher supports students' guided reinvention with these models through the use of questions, examples, and counterexamples that clarify how the models could be used.

As a result, MiC emphasizes that teachers' professional development experiences should address:

a. the function of problem contexts,
b. the rationale for various mathematical models and tools,
c. the sequencing of activities to promote progressive formalization of the mathematics, and
d. a multi-dimensional approach to assessing student understanding.

Another new challenge was the 2006 publication of the National Council of Teachers of Mathematics (NCTM) Focal Points. The Focal Points identify the curricular content focus of specific grades. If these recommendations are followed, there will be problems with Show-Me Project curricula. That's because they focus on well-articulated learning trajectories of content to be developed over several grades. The formalization of concepts is not always the first goal at a particular grade level in which the content is taught.

Next steps

Meyer says future curriculum development will continue to be influenced by the research-based efforts of the authors of the Show Me Project family of materials.

The lessons learned from this project cut across the four curriculum programs and share commonalities with standards-based curriculum reform at any level, Meyer says. She believes that documenting these lessons learned will be one of the legacies of the Show-Me Project.
How College Proximity Influences Enrollment

As U.S. high school students consider attending college, the ability to attend a college close to home is often a very important consideration.

It’s especially important for students from minority and low-income families.

One study estimates that about 54% of U.S. high school seniors had parents who said it was important for their children to live at home while attending college.

UW–Madison sociology professor Ruth López Turley says researchers should stop treating the college-choice process as though it were independent of location. It’s important to situate this process within its geographic context.

Living near colleges may be associated with a greater likelihood of going to college, says López Turley. Residents of counties with postsecondary institutions have higher rates of college enrollment than those without postsecondary institutions.

López Turley investigated the effect of college proximity on high school seniors’ college application and enrollment decisions. Using a national sample, she measured proximity by the number of colleges within commuting distance. The study addressed these questions:

- How are colleges distributed (by type) in relation to where students live?
- Are more colleges nearby associated with higher odds of enrolling in college?
- By what mechanism does college proximity affect students’ college choices?

Many high school seniors have a range of colleges within commuting distance, but distribution varies widely. Students in the East tend to have the most colleges nearby, while students in the South tend to have the fewest.

Having colleges nearby may affect a student’s chances of going to college in two ways. Having local colleges may influence local students’ propensity to strive for a college education (the predisposition mechanism).

Second, living close to a college may increase the odds of going to college simply because it makes the transition to college easier logistically, financially, and emotionally (the convenience mechanism).

The main difference between these mechanisms is that the first is associated with an increased likelihood of going to any college, while the second is associated with an increased likelihood of going to a nearby college.

Students from low-income families have significantly lower odds of applying to and enrolling in college in general. But they have significantly higher odds of applying to and enrolling in a nearby college, which corresponds with the convenience explanation.

López Turley notes a couple of limitations: Although the number of colleges within commuting distance is associated with higher odds of applying to and enrolling in a nearby college, it’s not necessarily associated with enrolling 2 years after completing high school. The study also suggests that although the effect of college proximity is statistically significant, it is smaller than the effect of other factors, such as test scores, race/ethnicity, and parents’ education.

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Familism Helps and Hinders Hispanic College Success

In 1980, only 8% of college graduates were Hispanic, and that percentage rose a mere two points by 2000, a paltry increase given the rapid demographic growth of Hispanic youth over the last two decades.

America’s preoccupation with illegal immigration and the growing Hispanic population has fueled anti-immigrant and anti-Hispanic sentiment. Like black students, Hispanic students often face prejudice in school. But that raises the question: Why are Hispanic students’ college application rates so much lower than those of black students, even though both groups are affected by the racial climate?

Only 22% of Hispanics between the ages of 18 and 24 enrolled in a postsecondary institution in 2000, compared to 39% of whites and 31% of blacks in this age bracket.

Family income level, parental education, school quality, and immigrant status all affect Hispanic students’ educational success. But these cannot fully account for Hispanic underachievement, says UW–Madison sociology professor Ruth López Turley. Many studies have concluded that familism is especially pronounced in Hispanic culture, and that it both helps and hinders Hispanic students.

López Turley and co-author Matthew Desmond define familism as a social pattern whereby one’s individual interests, decisions, and actions are conditioned by a network of relatives that takes priority over the individual.

Hispanics, and Mexican-Americans in particular, live in larger and denser kinship networks than whites. Hispanic adults and adolescents value interdependence and family obligations more so than whites.

Some college-bound Hispanic students find themselves pulled in two directions: They want to cultivate themselves. They’re willing to leave home, if the best education requires it. At the same time, another impulse encourages them to stay at home and uphold family ties that help shape their identity.

In a study of high school seniors, López Turley found that Hispanics are the most likely to say it’s important to live at home during college, even those with college-educated parents. But students who say it is important to stay home are significantly less likely to apply to college, especially to selective institutions.

Her recent study used data from the Texas Higher Education Opportunity Project. The study sample included 13,803 seniors attending 96 Texas public high schools in spring 2002.

Compared to whites and blacks, Hispanic high school seniors were significantly less likely to apply to:

- a selective college (14% versus 31% of whites and 19% of blacks)
- a four-year college (42% versus 55% of whites and 56% of blacks)
- any college (54% versus 66% for whites and 70% of blacks).

It’s important for educators to better understand Hispanic students’ desire to live at home during college, and the consequences of this decision on educational outcomes, says López Turley. Living away from home cultivates students’ independence and establishes bonds of mutual respect between parents and children. By comparison, students who stay home while attending school obtain lower levels of educational attainment. Living at home often whittles away students’ aspirations where family-related responsibilities confront them.

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Ruth López Turley

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Ruth López Turley
Summer Institute to Improve University Science Teaching

Every week seems to bring a new breakthrough in science. We live in a state of warp speed exploration, whether in deep-sea trenches or stellar nurseries billions of light years distant.

College students will tell you, however, that introductory science courses often disappoint. Teaching practices have not changed along with advances in scientific research. Somehow, large, anonymous classrooms are supposed to excite undergraduates about research and scientific ways of thinking.

But some high-enrollment undergraduate courses are being transformed into more effective, learner-centered environments, thanks to the work of WCER researchers Christine Pfund, Christline Pribbenow and colleagues from across the nation. An annual summer institute hosted at UW–Madison http://academiessummerinstitute.org/ encourages biology instructors to experiment with their teaching and to adopt more effective techniques.

Since 2004 the National Academies Summer Institute on Undergraduate Education in Biology has welcomed five cohorts of educators representing 64 U.S. institutions in 36 states. They include faculty and instructional staff from public and private institutions. The University of Wisconsin-Madison partners with the National Academies and the Howard Hughes Medical Institute to implement the program.

In a recent issue of Science, Pfund and colleagues show that alumni of the Summer Institute report significant learning gains in scientific teaching. Most alumni reported increased confidence in their ability to implement these strategies and expressed their intentions to do so. Two years after attending the Institute, 98% of those responding to a survey said they were still experimenting to improve their teaching. Specific changes in teaching activities include using case studies, clickers, and cooperative groups. Alumni reported substantial increases in their use of learner-centered classroom activities, measuring student learning and teaching effectiveness, and employing diversity-aware teaching strategies. Nearly 70% of participants reported using these methods in at least half of their class sessions.

Changing one’s teaching is not easy. Among their major challenges, alumni reported time pressures, balancing responsibilities, and lack of recognition for their teaching efforts. However, some alumni commented that attending the Institute helped them to negotiate change.

Evaluating a Core Reading Program

If you’re a fourth-grader you could be the victim of an achievement gap equivalent to nearly 3 years of learning, depending on whether you are African-American, Hispanic, White, poor, or non-poor (U.S. Department of Education, 2005).

Despite many efforts to close this gap, early elementary literacy instruction and learning still falls many of America’s poor and minority students.

Educators are trying. But they can’t find all they need in the professional literature on core reading programs. UW–Madison education professor Geoffrey Borman finds that current published research offers few studies that examine the impact of these programs on children’s reading skills. To help remedy this shortcoming, Borman and colleagues Maritza Dowling and Carrie Schneck evaluated and reported on one such program, Open Court Reading (OCR). OCR is a phonics-based K–6 curriculum grounded in research-based practices. It has been widely used since the 1960s. But despite its widespread use, OCR had not been evaluated rigorously. Borman and Dowling initiated a study to answer two questions:

- Is it possible or desirable to use randomized field trials to measure widely used core reading programs?
- How effective is OCR in particular?

During the 2005–06 school year Borman and Dowling studied elementary school classrooms from Grades 1 through 5. This was a randomized controlled trial: Some classrooms were assigned to use OCR, the others were not.

Borman’s final sample included 5 schools, from which 49 Grade 1–5 classrooms and 917 to 923 students participated. (Sample and data attrition claimed some of the control students, the treatment students, and participating classrooms.)

The study findings should prove significant for curriculum leaders, literacy leaders, researchers, and policymakers.

Curriculum and literacy leaders: Borman’s study determined that the average student from an OCR classroom outperformed nearly 58% of the students in classrooms that were not assigned to OCR. Overall, students from OCR classrooms scored from 12% to 19% of 1 standard deviation higher on reading assessments. (The effect sizes for OCR are essentially equivalent to the impact for class-size reductions found through the Tennessee Student-Teacher Achievement Ratio [STAR] study.)

Researchers and policymakers: Cluster randomized field trials (like this one) involving widely replicated school-based interventions (like OCR) are both possible and desirable for producing unbiased estimates of the effects of educational treatments. These outcomes provide evidence of the promising 1-year effects of OCR on students’ reading outcomes, Borman says. They also suggest that these effects may be replicated across varying contexts with rather consistent and positive results.