

Improving Student Learning – What Works

The Glenn Commission report, *Before It's Too Late*¹, concludes that the key to improving mathematics and science achievement of K-12 students is to improve mathematics and science teaching. The report recognizes that instruction and learning depend on the interaction of teachers, students, and content in classroom contexts.

Effective mathematics teaching depends on a teacher's knowledge and use of mathematical content, on how teachers attend to the work of students, and on how students engage with mathematical tasks.² A teacher's expectations about what students are able to learn significantly influences the opportunities and motivation that students have for learning. The goal is to develop students who are mathematically proficient.

Mathematically proficient students have conceptual understanding, are able to complete procedures accurately and efficiently, are able to formulate and solve real-world problems, can justify their thinking about a problem, and have confidence that they are competent in mathematics. For students to be mathematically proficient, teachers need to develop instruction that addresses and integrates these components of proficiency.³ This requires that teachers understand the content they are expected to teach as well as possess knowledge about how students learn and how they might facilitate that learning. Teachers must be flexible and able to adapt instruction to address difficulties that arise when they teach.

Plans for developing students who are mathematically proficient must consider three interrelated aspects:

1. instruction and teacher quality,
2. curriculum, and
3. teacher professional development.

Each of these issues is addressed below.

Instruction and Teacher Quality

Both the National Council of Teachers of Mathematics and the American Council on Education recognize that the quality of the teacher has an enormous influence on the

¹ *Before It's Too Late: A Report to the Nation from the National Commission on Mathematics and Science Teaching for the 21st Century*. Washington, DC: U.S. Department of Education, 2000.

² Kilpatrick, J., Swafford, J., & Findell, B. (Eds.) *Adding It Up: Helping Children Learn Mathematics*. Washington, DC: National Academy Press, 2001.

³ *Adding It Up*.

achievement that students attain.^{4,5} Effective teachers have knowledge of their subject matter, teaching practices related to that subject matter, and curriculum.⁶ That is, in addition to the mathematics and science content knowledge that teachers need, they also need appropriate knowledge in how to teach that content effectively so that students will learn. The ability of teachers to structure material, ask questions that focus on higher-order thinking, build upon students' ideas, and probe students' thinking are important variables in what students are able to learn.⁷

However, although teachers' content preparation is positively related to student achievement in mathematics, beyond a threshold level additional content coursework does not necessarily lead to enhanced student achievement. Content specific education coursework has been found to be more influential than additional advanced subject matter courses.⁸

Issues related to teacher quality and preparation arose during the development of a statewide report for the Florida Department of Education on *Improving Middle School Mathematics Achievement in Florida*.⁹ Teachers, school-level leaders, district-level mathematics specialists, curriculum specialists, university teacher educators, and parents in focus groups held throughout the state discussed barriers to the implementation of successful middle-school mathematics programs and provided possible solutions to overcome the barriers. Many of their recommendations are appropriate at all levels, not just the middle-school level. For state policy makers, this group offered the following recommendations related to developing a sufficient supply of qualified mathematics teachers:

- Support alternative certification programs that meet the same standards as undergraduate university programs.
- Maintain high requirements for middle-grades mathematics certification [as well as secondary mathematics certification].
- Make middle-grades certification content-specific.
- Create incentives for highly qualified students to enter teaching.
- Provide financial support for education majors in critical need areas.
- Create incentives to retain teachers in critical need areas.
- Support a media campaign to encourage entry into teaching.

⁴ National Council of Teachers of Mathematics. *Principles and Standards for School Mathematics*. Reston, VA, 2000.

⁵ American Council on Education. *To Touch the Future: Transforming the Way Teachers Are Taught. An Action Agenda for College and University Presidents*. Washington, DC, 1999.

⁶ Shulman, L. S. "Paradigms and Research Programs in the Study of Teaching: A Contemporary Perspective." In *Handbook of Research on Teaching and Learning* (3rd Ed.), edited by Merlin C. Wittrock, pp. 3-36. New York: Macmillan, 1986.

⁷ Darling-Hammond, L., Wise, A., & Pease, S. R. (1983). "Teacher Evaluation in the Organizational Context: A Review of the Literature." *Review of Educational Research*, 53(3): 285-328.

⁸ Monk, D. H. (1994). "Subject Area Preparation of Secondary Mathematics and Science Teachers and Student Achievement." *Economics of Education Review*, 13(2): 125-144.

⁹ Thompson, D. R. & Kersaint, G. *Improving Middle School Mathematics Achievement in Florida: Condensed Report*. Report prepared for the Florida Department of Education, 2001. (available at <http://www.firm.edu/doe/dps/memos/01-080a.pdf>)

Curriculum and Instruction

Curriculum needs to be coherent and focused in order for it to function successfully to enhance student achievement. The U.S. curriculum is often characterized as shallow and covering more topics in less depth than the curriculum in other countries.¹⁰ An effective curriculum must be able to adjust to the needs of learners while still helping students meet established performance goals.¹¹

Despite state or district standards, high and low performing schools often differ in the nature of the mathematics curriculum that is offered to students. High performing schools provide challenging curricula that emphasize the intellectual development of students; low performing schools often use curricula that emphasize social development and low-level skills.¹²

In addition to curriculum, the nature of instruction in high and low performing schools is often different. To develop mathematically powerful students, teachers need to engage learners in “doing” mathematics rather than in just “receiving” knowledge from the teacher. Teachers who are helping students grow mathematically actively involve students in doing mathematics in real-world situations rather than telling students about mathematics, expecting rote memorization of procedures, or focusing solely on computational practice.¹³ In classrooms with high expectations, more time is spent on learning than on discipline, performance criteria are clearly identified for students, teachers believe students can learn and solve problems, students are expected to reflect on and analyze mathematics, multiple instructional methods are used, and learning connects to students’ lives.¹⁴

In developing the statewide report on improving middle-school mathematics achievement, participants made the following recommendations for policy makers relative to curriculum and instruction:

- Encourage and fund articulation K-16.
- Create and enforce accountability policies for students and parents.

Regarding curriculum and instruction, the participants made the following recommendations:

- Adopt curriculum materials that represent a challenging, coherent, and focused curriculum from grade to grade.
- Balance conceptual understanding of mathematics with procedural understanding.
- Support teaching fewer topics but at greater depth.¹⁵

¹⁰ *Adding It Up*.

¹¹ Wiggins, G. “Curricular Coherence and Assessment: Making Sure That the Effect Matches the Intent.” In *Toward a Coherent Curriculum* (1995 ASCD Yearbook), edited by James A. Beane, pp. 101-119. Alexandria, VA: Association for Supervision and Curriculum Development, 1995.

¹² Cooney, S. *Education’s Weak Link: Student Performance in the Middle Grades*. Southern Regional Education Board, 1999.

¹³ Zemelman, S., Daniels, H., & Hyde, A. *Best Practices: New Standards for Teaching and Learning in America’s Schools*. (Second Edition). Portsmouth, NH: Heinemann, 1998.

¹⁴ Cooney, S. *Raising the Bar in the Middle Grades: Readiness for Success*. Southern Regional Education Board, 1999.

¹⁵ *Improving Middle School Mathematics Achievement in Florida*.

Teacher Professional Development

Professional development is an important means of helping teachers become more effective and providing them opportunities to learn new strategies over time. Just as businesses regularly provide professional development for their employees, policymakers need to consider professional development for educational personnel as an essential component of an effective school and build a budget accordingly so that professional development is not routinely eliminated when times are difficult and budgets are lean.¹⁶

Research generally shows that professional development that focuses on how students learn is more effective than professional development that focuses on teacher behaviors,¹⁷ particularly when teachers try new approaches in their own classrooms and see benefits to their own students' learning.¹⁸ Further, professional development that is sustained over time is more effective than one time experiences.¹⁹ Thus, research indicates that long-term professional development focused on the content of classes teachers teach, and on how students learn that content, is the most effective model of professional development.

In the statewide focus on middle-school achievement, participants made the following recommendations for policy makers relative to professional development:

- Fund, administer, and facilitate summer institutes.
- Support quality [professional development] programs.
- Develop networks for the sharing of ideas.
- Fund an extended school year [for teachers] to include days for professional development.
- Fund enhanced summer course offerings at universities.
- Integrate content, how students learn that content, and how to teach that content in staff development.
- Provide mathematics resource teachers at each school.²⁰

Summary

This brief report has focused on issues of curriculum, instruction, teacher quality, and professional development that are critical aspects of improving mathematics achievement in Florida at the K-12 level. Throughout each of the three sections, recommendations made by

¹⁶ Loucks-Horsley, S., Hewson, P. W., Love, N., & Stiles, K. E. *Designing Professional Development for Teachers of Science and Mathematics*. Thousand Oaks, CA: Corwin Press, 1998.

¹⁷ Kennedy, M. M. (November 1999). "Form and Substance in Mathematics and Science Professional Development." *National Institute for Science Education Brief*, 3(2).

¹⁸ Guskey, T. R. (1986). "Staff Development and the Process of Teacher Change." *Educational Researcher*, 15(5): 5-12.

¹⁹ Sparks, D. & Hirsh, S. *A National Plan for Improving Professional Development*. Oxford, OH: National Staff Development Council, 2000.

²⁰ *Improving Middle School Mathematics Achievement in Florida*.

Florida educators and parents have been shared; these recommendations are aligned with national recommendations for improving mathematics achievement made in *Adding It Up*:

- The integrated and balanced development of all [aspects] of mathematical proficiency ... should guide the teaching and learning of school mathematics. Instruction should not be based on extreme positions that students learn ... solely by internalizing what a teacher or book says or ... solely by inventing mathematics on their own.
- Teachers' professional development should be high quality, sustained, and systematically designed and deployed to help all students develop mathematical proficiency. Schools should support, as a central part of teachers' work, engagement in sustained efforts to improve their mathematics instruction. This support requires the provision of time and resources.
- The coordination of curriculum, instructional materials, assessment, instruction, professional development, and school organization around the development of mathematical proficiency should drive school improvement efforts.
- Efforts to improve students' mathematics learning should be informed by scientific evidence, and their effectiveness should be evaluated systematically. Such efforts should be coordinated, continual, and cumulative.²¹

Implementing these recommendations requires resources that only policy makers can provide.

Prepared for the 2005 Florida Summit on Mathematics & Science Education

By

Denisse R. Thompson
Professor of Mathematics Education
University of South Florida, Tampa

²¹ *Adding It Up*, pp. 11-13.