

Everyday Mathematics Research Summary

University of Chicago School Mathematics Project

2/4/05

The research evidence about *Everyday Mathematics* (EM) almost all points in the same direction: Children who use EM tend to learn more mathematics and like it better than children who use other programs. This finding has been supported by research carried out by the University of Chicago School Mathematics Project (UCSMP), by independent researchers at other universities, and by many school districts across the nation. The absolute amount of this research is large – the reports fill several large binders – but, compared to what is available for other curricula, it is enormous. As a recent report from the National Academy of Sciences (NRC, 2004) makes clear, no other currently available elementary school mathematics program has been subjected to so much scrutiny by so many researchers. The agreement about the curriculum across so many research studies is, itself, perhaps the strongest evidence that EM is effective.

Attached to this memo is an annotated bibliography of research about EM. One of the articles in this bibliography, the chapter by Carroll and Isaacs in *Standards-Based School Mathematics Curriculum: What Are They? What Do Students Learn?* (2003), summarizes research about EM before roughly 1998. Here we briefly summarize some of the more important studies that have been completed since then. Note that all but one of these studies has appeared in a peer-reviewed journal; the one that has not (Sconiers, Isaacs, Higgins, McBride, & Kelso, 2003) is currently under review at the *Journal for Research in Mathematics Education*.

Please contact the UCSMP *Everyday Mathematics* Center at em-center@uchicago.edu with any questions or comments about this research summary or visit our website at everydaymath.uchicago.edu.

National Research Council. (2004). *On evaluating curricular effectiveness: Judging the quality of K-12 mathematics evaluations*. Committee for a Review of the Evaluation Data on the Effectiveness of NSF-Supported and Commercially Generated Mathematics Curriculum Materials. Confrey, J. & Stohl, V. (Eds.), Mathematics Science Education Board, Center for Education, Division of Behavioral and Social Science and Education. Washington, DC: The National Academies Press.

Carroll, W. M. (2001). Students in a Standards-based mathematics curriculum: Performance on the 1999 Illinois State Achievement Test. *Illinois Mathematics Teacher*, 52(1), 3–7.

- This paper reports a study of the performance of Chicago-area EM students on the 1999 Illinois Standards Achievement Test (ISAT). The study compared 12,880 third-grade EM students and 11,213 fifth-grade EM students with 47,742 third-grade non-EM students and 50,023 fifth-grade non-EM students.
- The study found that EM students significantly outperformed comparison students, even after controlling for all other significant variables such as percent low-income and per-pupil expenditure.
- The study also found that, “the differences favoring the EM curriculum were largest in schools with a higher percentage of low-income students” (p. 5).

Riordan, J. E., & Noyce, P. E. (2001). The impact of two standards-based mathematics curricula on student achievement in Massachusetts. *Journal for Research in Mathematics Education*, 32(4), 368–398.

- This paper reports results of a quasi-experimental study of the performance of fourth grade EM and eight grade Connected Mathematics students on the 1999 Massachusetts state test. The study included the entire population of EM students. “Results attest to the effect of these curriculum programs as actually implemented under ordinary prevailing conditions in unselected schools, without regard to whether the programs were implemented optimally” (p. 390).
- 67 EM schools were included, 48 of which had implemented the program for four or more years. Comparison schools were chosen to match the EM schools on math scores from the year before the introduction of EM and the percentage of low-income students.
- The results “indicate that Everyday Mathematics schools outperformed comparison schools in all question types and all reporting categories, except that there was no difference in statistics for early implementers and in geometry for later implementers” (p. 389).
- “The positive impact of the standards-based programs on student performance was remarkably consistent across students of different gender, race, and economic status. Students at the top, bottom, and middle of their classes all did better with the standards-based programs than did their counterparts using traditional programs. ... For schools that had adopted these programs at least four years ago, early gains were sustained or increased further over time” (p. 390).
- “These findings suggest a progressive achievement gain for Everyday Mathematics, that is, a positive longitudinal effect of the program on achievement” (p. 387).

Carroll, W. M., Fuson, K. C., & Diamond, A. (2000). Use of student-constructed number stories in a reform-based curriculum. *Journal of Mathematical Behavior*, 19, 49–62.

Carroll, W. M. (2000). Invented computational procedures of students in a Standards-based Curriculum. *Journal of Mathematical Behavior*, 18(2), 111–121.

Fuson, K. C., Carroll, W., & Drucek, J. (2000). Achievement results for second and third graders using the Standards-based curriculum *Everyday Mathematics*. *Journal for Research in Mathematics Education*, 31(3), 277–295.

- These papers report results from a five-year longitudinal study of EM funded by the National Science Foundation and carried out by Karen Fuson’s group at Northwestern University.
- The project followed several hundred children using the first edition of EM in Grades 1-5 from 1992 through 1997. The project produced two dissertations, many articles in peer-reviewed journals, and a series of reports about strengths and weaknesses of EM that were used in the revisions that led to the second edition.
- The project found that EM students outperformed comparison students across all grades and raised achievement to levels approaching that of high-performing Asian countries. “On traditional vertical symbolic multi-digit addition and subtraction, EM students performed as well as students using traditional approaches. On a wide range of other mathematically and conceptually demanding tasks, EM students outperformed other groups” (Fuson, Carroll, & Drucek, 2000, p. 292).

Schoenfeld, A. H. (2002). Making mathematics work for all children: Issues of standards, testing, and equity. *Educational Researcher*, 31 (1), pp. 13-25.

- Alan H. Schoenfeld is past president of the American Educational Research Association, Vice President of the National Academy of Education, and a Fellow of the American Association for the Advancement of Science. Schoenfeld has a PhD in mathematics from Stanford and is a professor in the Graduate School of Education at UC Berkeley.
- This paper, available at http://www.aera.net/pubs/er/pdf/vol31_01/AERA310104.pdf, summarizes several research studies that have to do with EM, including Riordan and Noyce (2001), Briars and Resnick (2000), Carroll and Isaacs (2003), and a study from the Michigan Invitational Group, a coalition of school districts, many of whom use EM.
- “To briefly summarize the current state [of research on large-scale implementation of reform curricula], a converging body of data indicates the following:
 - “1. On test of basic skills, there are no significant performance differences between students who learn from traditional or reform curricula.
 - “2. On tests of conceptual understanding and problem solving, students who learn from reform curricula consistently outperform students who learn from traditional curricula by a wide margin.
 - “3. There is some encouraging evidence that reform curricula can narrow the performance gap between Whites and under-represented minorities.... “In short, the fears of anti-reform groups that reform curricula would cause a decrease in student skill levels appear to be unwarranted.
“Data such as these indicate that coherent approaches to teaching mathematics for conceptual understanding produce significant improvements across the board – not only in concepts and problem solving, but in skills as well” (p. 16).
- Concludes from the research that, “The bottom line is that standards-based reform appears to work when it is implemented as part of a coherent systemic effort in which curriculum, assessment, and professional development are aligned. Not only do many more students do well, but the racial performance gap diminishes substantially” (p. 17).
- “... the Michigan data indicate that when standards, assessment, curriculum, and professional development are appropriately aligned, low-SES districts can perform as well on meaningful assessments as other much more wealthy districts” (p. 21).

Baxter, J. A., Woodward, J., & Olson, D. (2001). Effects of reform-based mathematics instruction on low achievers in five third-grade classrooms. *Elementary School Journal*, 101(5), 529–547.

- This paper extends an earlier study of learning disabled children using the first edition of third grade EM (Woodward & Baxter, 1997). The earlier study used the Iowa Test of Basic Skills and the Informal Mathematics Assessment, a test of problem solving abilities, and found that EM was effective for average- and high-ability students, but less effective for lower-ability students.
- The study used surveys, interviews, and classroom observations to examine the difficulties low-achieving students face when working with curricula such as EM, and identified the formation of a community of learners and the cognitive load as key features of the curriculum that need to be considered in relation to low achievers.

- The article concludes, “We strongly believe that it is unwarranted to conclude from our work that reform-based mathematics should be abandoned when teaching low achievers; however, our work does suggest that many of these students may be struggling and need additional support.”

Sconiers, S., Isaacs, A., Higgins, T., McBride, J., & Kelso, K. R. (2003) The ARC Center tri-state student achievement study. Lexington, MA: The Consortium for Mathematics and Its Applications. (Currently under review at the *Journal for Research in Mathematics Education*.)

- This paper reports results of a large-scale study of 100,000 children in Illinois, Massachusetts, and Washington State using standards-based elementary mathematics curricula. The study was funded by the National Science Foundation.
- The study included 39,701 students who had studied with EM for at least two years and 38,481 students from non-using comparison schools carefully matched by reading level, socioeconomic status, and other variables.
- Student performance was measured by the state-mandated tests in the three states: the fourth-grade MCAS in Massachusetts, the third- and fifth-grade ISATs in Illinois, and the third-grade Iowa Test of Basic Skills and fourth-grade WASL in Washington.
- The results show that the average scores of the EM students are significantly higher than the average scores of students in their matched comparison schools. The results hold across the different state-mandated tests, and across all topics, including computation, measurement, geometry, algebra, problem solving, and making connections.
- The study compared the scores on all the topics tested at all the grade levels tested (Grades 3-5) in each of the three states. Of 34 comparisons across five state-grade combinations, 29 favor the EM students, five show no statistically significant difference, and none favor the comparison students. The results also hold across all income and racial subgroups – except for Hispanic students, where Everyday Mathematics students have higher (but not statistically significantly higher) average scores.

Waite, R. D. (2000). *A study of the effects of Everyday Mathematics on student achievement of third-, fourth-, and fifth-grade students in a large North Texas Urban School District*. Ann Arbor, Michigan: UMI.

- This is a doctoral dissertation, which was directed by Hoyt Watson, from the University of North Texas.
- The study compared the performance of students in a large North Texas school district who were taught with two different mathematics curricula. One curriculum, used in six schools, was *Everyday Mathematics*; the other curriculum, used in 12 schools, was a more traditional, district-approved textbook from a large publisher. The schools were matched by SES, ethnic makeup, and prior ITBS mathematics scores.
- After one year of *Everyday Mathematics* usage, “almost all comparisons showed that the experimental group taught with the *Everyday Mathematics* curriculum had higher scores on the 1999 Texas Assessment of Academic Skills mathematics test. When compared to children with similar mathematics ability at the beginning of the 1998-99 school year, the students in this study who were taught using *Everyday Mathematics* showed greater achievement gains than students in classes that used the district-approved curriculum” (p. 2).

***Everyday Mathematics* Research Bibliography**

This bibliography is divided into five sections:

- *Research studies that form the basis of the curriculum*
- *Formative studies conducted during the development of the curriculum*
- *Reports from Northwestern University's five-year longitudinal study*
- *Summative studies by UCSMP and non-UCSMP researchers*
- *School and district studies*

1. The Research Basis

The *Everyday Mathematics* curriculum is based on the authors' own academic research into young children's mathematical abilities, as well as on systematic surveys of the mathematics education research literature for effective classroom practices. The papers in this section provide an overview of the research foundations of the curriculum.

Bell, M. S. (1994). What does "Everyman" really need from school mathematics? (Reprint of 1974 article). *Mathematics Teacher*, 87(7), 546–551.

Isaacs, A., Carroll, W., & Bell, M. (1998). A research-based curriculum: The research foundations of the UCSMP *Everyday Mathematics* curriculum. Chicago: University of Chicago School Mathematics Project Elementary Component.

Usiskin, Z. (1988). The beliefs underlying UCSMP. *UCSMP Newsletter*, Winter, 9–15.

2. Formative Studies

Each grade level of the *Everyday Mathematics* program went through a three-year development cycle that included a year of writing, a year of extensive field-testing in a cross-section of classrooms, and a year of revising. During the field-test phase, implementation and achievement data were gathered and analyzed, and the resulting findings were used as a basis for the revisions. This section includes unpublished papers that summarize some of the field-test research.

Carroll, W. M. (1995). Report on the field test of Fifth Grade *Everyday Mathematics*. Chicago: University of Chicago School Mathematics Project Elementary Component.

Carroll, W. M. (1996). A follow-up to the fifth-grade field test of *Everyday Mathematics*: Geometry and mental and written computation. Chicago: University of Chicago School Mathematics Project Elementary Component.

Carroll, W. M., & Porter, D. (1994). Summary report: A field test of fourth grade *Everyday Mathematics*. Chicago: University of Chicago School Mathematics Project Elementary Component.

Hedges, L. V., Stodolsky, S. S., & Mathison, S. (1987). A formative evaluation of Kindergarten *Everyday Mathematics* (Evaluation report #86/87-KEM-1). Chicago: University of Chicago School Mathematics Project.

Hedges, L. V., Stodolsky, S. S., & Mathison, S. (1988). A follow-up of Kindergarten *Everyday*

- Mathematics Users* (Evaluation report #87/88-KEM-2). Chicago: University of Chicago School Mathematics Project.
- Northwestern University Longitudinal Study of Everyday Mathematics. (1998a). Suggestions for the revision of Fourth Grade *Everyday Mathematics*: Findings from the Northwestern University Longitudinal Study.
- Northwestern University Longitudinal Study of *Everyday Mathematics*. (1998b). Fourth-grade feedback on specific lessons.
- Northwestern University Longitudinal Study. (undated-a). Suggestions for the revision of Fifth-Grade *Everyday Mathematics*: Findings from the Northwestern University Longitudinal Study.
- Northwestern University Longitudinal Study. (undated-b). Summary report: Recommendations for revisions of *Everyday Mathematics*: Lessons learned from observations (Report from the Northwestern University Longitudinal Study).
- Northwestern University Longitudinal Study. (undated-c). Draft 4EM results, received 3-25-99 (Report from the Northwestern University Longitudinal Study).

3. Northwestern's Longitudinal Study

Researchers at Northwestern University conducted a five-year longitudinal study of the *Everyday Mathematics* curriculum. The study used student and teacher interviews, classroom observations, written tests and surveys, and collected artifacts. These papers summarize the findings of the Northwestern study. Carroll (2001) provides the most comprehensive overview of this research.

- Carroll, W. M. (2001). A longitudinal study of children in the *Everyday Mathematics* curriculum. Chicago: University of Chicago School Mathematics Project.
- Drueck, J. V., Fuson, K. C., Carroll, W. M., & Bell, M. S. (1995). Performance of U.S. first graders in a reform math curriculum compared to Japanese, Chinese, and traditionally taught U.S. students. Paper presented at the annual meeting of the American Educational Research Association, San Francisco.
- Fuson, K. C. (1997). What do we see in *Everyday Mathematics* classrooms? *TeacherLink*, 5(2), 1–2. Chicago: Everyday Learning Corporation.
- Fuson, K. C., Carroll, W., & Drueck, J. (2000). Achievement results for second and third graders using the Standards-based curriculum *Everyday Mathematics*. *Journal for Research in Mathematics Education*, 31(3), 277–295.

See also Northwestern University Longitudinal Study of *Everyday Mathematics* (1998a, 1998b, undated-a, undated-b, undated-c) in the “Formative Studies” section.

4. Summative Studies

Most of the reports in this section have been published in peer-reviewed journals. Three doctoral dissertations (Fraivillig, 2001; Murphy, 1999; Waite, 2000) are also included. Important papers in this section include Baxter, Woodward, & Olson (2001); Noyce & Riordan (2001); Woodward & Baxter (1997); and Sconiers, Isaacs, Higgins, McBride, & Kelso (2003). The last is a report of a wide-scale study of the effects of reform curricula on student achievement. The study included over 100,000 students in three states. Approximately 75% of the students in the experimental group of this study used *Everyday Mathematics*.

- Baxter, J. A., Woodward, J., & Olson, D. (2001). Effects of reform-based mathematics instruction on low achievers in five third-grade classrooms. *Elementary School Journal*, 101(5), 529–547.
- Carroll, W. M. (1996). Mental computation of students in a reform-based mathematics curriculum. *School Science and Mathematics*, 96(6), 305–311.
- Carroll, W. M. (1996). Use of invented algorithms by second graders in a reform mathematics curriculum. *Journal of Mathematical Behavior*, 15(2), 137–150.
- Carroll, W. M. (1997). Results of third-grade students in a reform curriculum on the Illinois state mathematics test. *Journal for Research in Mathematics Education*, 28(2), 237–242.
- Carroll, W. M. (1998a). Geometric knowledge of middle school students in a reform-based mathematics curriculum. *School Science and Mathematics*, 98(4), 188–195.
- Carroll, W. M. (1998b). Middle school students' reasoning about geometric situations. *Mathematics Teaching in the Middle School*, 3(6), 398-403.
- Carroll, W. M. (2000). Invented computational procedures of students in a Standards-based Curriculum. *Journal of Mathematical Behavior*, 18(2), 111–121.
- Carroll, W. M. (2001). Students in a Standards-based mathematics curriculum: Performance on the 1999 Illinois State Achievement Test. *Illinois Mathematics Teacher*, 52(1), 3–7.
- Carroll, W. M., Fuson, K. C., & Diamond, A. (2000). Use of student-constructed number stories in a reform-based curriculum. *Journal of Mathematical Behavior*, 19, 49–62.
- Carroll, W. M., Isaacs, A. (2003). Achievement of Students Using the University of Chicago School Mathematics Project's *Everyday Mathematics*. In S. L. Senk & D. R. Thompson (Eds.) *Standards-Based School Mathematics Curriculum: What Are They? What Do Students Learn?* (pp. 79–108). Mahwah, NJ: Laurence Erlbaum Associates.
- Drueck, J. V. (1996). Progression of multidigit addition and subtraction solution methods in high-, average-, and low-math-achieving second graders experiencing a reform curriculum. Paper presented at the annual meeting of the American Educational Research Association, New York.
- Fraivillig, J. L. (1996). Case studies and instructional frameworks of expert reform mathematics teaching (Doctoral dissertation, Northwestern University). *Dissertation Abstracts International*, 57(06), 2400.
- Fraivillig, J. L. (2001). Strategies for advancing children's mathematical thinking. *Teaching Children Mathematics*, 7(8), 454–459.
- Fraivillig, J. L., Murphy, L. A., & Fuson, K. C. (1999). Advancing children's mathematical thinking in *Everyday Mathematics* classrooms. *Journal for Research in Mathematics Education*, 30(2), 148–170.
- Hawkes, M., Kimmelman, P., & Kroeze, D. (1997). Becoming 'first in the world' in math and science. *Phi Delta Kappan*, 79(1), 30–33.
- Kroeze, D. J., Johnson, D. P., & Zalewski, E. (1997). Achieving excellence: A report of initial findings of eighth grade performance from the Third International Mathematics and Science Study: First in the World Consortium. Oak Brook, IL: North Central Regional Educational Laboratory.
- Murphy, L. A. (1999). Learning and affective issues among higher- and lower-achieving third-graders in math reform classrooms: perspectives of children, parents, and teachers (Doctoral dissertation, Northwestern University, 1998). *Dissertation Abstracts International*, 59(12), 4358.

- Riordan, J. E., & Noyce, P. E. (2001). The impact of two standards-based mathematics curricula on student achievement in Massachusetts. *Journal for Research in Mathematics Education*, 32(4), 368–398.
- Sconiers, S., Isaacs, A., Higgins, T., McBride, J., & Kelso, C. R. (2003) The ARC center tri-state student achievement study. Lexington, MA: The Consortium for Mathematics and Its Applications.
- Waite, R. D. (2000). *A study of the effects of Everyday Mathematics on student achievement of third-, fourth-, and fifth-grade students in a large North Texas Urban School District*. Ann Arbor, Michigan: UMI.
- Woodward, J., & Baxter, J. (1997). The effects of an innovative approach to mathematics on academically low-achieving students in inclusive settings. *Exceptional Children*, 63(3), 373–389.

5. School and District Reports

These reports summarize research conducted by individual schools and districts. The most important of these studies is Briars and Resnick (2000). Many of the studies in the *Student Achievement Studies* booklets are not particularly “scientific,” but they do have high “face validity” and provide evidence that *Everyday Mathematics* has a positive effect on student achievement. (Note: Some of the studies in the *Student Achievement Studies* booklets, particularly in Volumes 1 and 4, are not school or district studies. These studies are also represented in reports in other sections of this bibliography.)

- Briars, D. J., & Resnick, L. B. (2000). Standards, assessment—and what else? The essential elements of standards-based school improvement [CSE Technical Report 528]. Los Angeles: Center for the Study of Evaluation, UCLA. (<http://www.cse.ucla.edu/CRESST/Reports/TECH528.pdf>)
- Carroll, W. M., & Fuson, K. C. (1998). A comparison of *Everyday Math* (EM) and McMillan (MC) on Evanston student performance on whole-class tests: Recommendations for revision of *Everyday Mathematics* Grades 1, 2, 3, and 4. Evanston, IL: Northwestern University.
- Everyday Learning Corporation. (1996). *Everyday Mathematics: Student achievement studies*. Chicago: Author.
- Everyday Learning Corporation. (1998). *Everyday Mathematics gets results: Student achievement studies: Volume 2*. Chicago: Author.
- Mathematics Evaluation Committee of the Hopewell Valley Regional School District. (1997). *Mathematics evaluation report: Year two*. Pennington, NJ: Hopewell Valley Regional School District.
- SRA/McGraw-Hill. (2001). *Everyday Mathematics student achievement studies: Volume 3*. Chicago: Author.
- SRA/McGraw-Hill. (2003). *Everyday Mathematics student achievement studies: Volume 4*. Chicago: Author.