Final Report of the Coordinating Review Committee for the National Council of Teachers of Mathematics: Principles and Standards for School Mathematics

Center for Education, National Research Council
ISBN: 0-309-55856-5, 19 pages, 8.5 x 11, (2000)

Final Report

Coordinating Review Committee for the National Council of Teachers of Mathematics *Principles and Standards for School Mathematics*

Center for Science, Mathematics, and Engineering Education
Center for Education
National Research Council

A letter report of the Coordinating Review Committee, prepared for the National Council of Teachers of Mathematics with support from the National Science Foundation.

May 2000

NOTICE: The project that is the subject of this report was approved by the Governing Board of the National Research Council, whose members are drawn from the councils of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine. The members of the committee responsible for the report were chosen for their special competences and with regard for appropriate balance.

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This study was conducted by Grant No. ESI-9907187 between the National Science Foundation and the National Academy of Sciences/National Research Council. Any opinions, findings, conclusions, or recommendations expressed in this report are those of the members of the committee and do not necessarily reflect the views of the sponsor.

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This report is also available online at http://www.nap.edu

Printed in the United States of America

Second printing, with corrections, November 2000

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NCTM/*PSSM* COORDINATING REVIEW COMMITTEE

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** Through January 2000

ACKNOWLEDGMENTS

This report has been reviewed in draft form by individuals chosen for their diverse perspectives and technical expertise, in accordance with procedures approved by the Report Review Committee of the National Research Council. The purpose of this independent review is to provide candid and critical comments that will assist the institution in making the published report as sound as possible and to ensure that the report meets institutional standards for objectivity, evidence, and responsiveness to the study charge. The review comments and draft manuscript remain confidential to protect the integrity of the deliberative process.

We thank the following individuals for their participation in the review of this report: Ed Esty, U.S. Department of Education; Rol Fessenden, L.L. Bean; Deborah Hughes-Hallett, University of Arizona; Sharon McCrone, Illinois State University; Doug McLeod, San Diego State University; Peter Raven, Missouri Botanical Garden, St. Louis; Lynn Steen, St. Olaf College.

While the individuals listed above have provided many constructive comments and suggestions, responsibility for the final content of this report rests solely with the authoring committee and the NRC.

The following people also attended the open session as guests. The NCTM/*PSSM* Coordinating Review Committee would like to acknowledge their attendance: Joan Ferrini-Mundy, Shelley Ferguson, Francis "Skip" Fennell, Jeane Joyner, Glenda Lappan, Gary Martin, Barbara Reys, Jim Sandefur, and John Thorpe

FINAL REPORT OF THE COORDINATING REVIEW COMMITTEE FOR THE NATIONAL COUNCIL OF TEACHERS OF MATHEMATICS

PRINCIPLES AND STANDARDS FOR SCHOOL MATHEMATICS

A letter report of the Coordinating Review Committee, prepared for the National Council of Teachers of Mathematics with support from the National Science Foundation

May 2000

INTRODUCTION

The Center for Science, Mathematics, and Engineering Education of the National Research Council (NRC) convened a committee to review the process of revising the *Principles and Standards for School Mathematics (PSSM): Discussion Draft* at the request of the National Science Foundation (NSF), in conjunction with the National Council of Teachers of Mathematics (NCTM). This committee was established in the Center for Science, Mathematics, and Engineering Education, which received initial input and guidance from the Mathematical Sciences Education Board (MSEB) concerning committee membership and the statement of task. However, neither individual members of MSEB nor the Board as a whole participated in the deliberations of the committee, nor were they involved in the determination of the findings and recommendations of the committee.

The committee was charged with reacting to the NCTM/*PSSM* Writing Group's plan to address the issues identified in the review comments and with evaluating the adequacy and appropriateness of the Writing Group's responses to these issues in their revision of *PSSM*. In particular, the committee was to "work from a synthesis of reviews and a revised draft to provide critical, high-level input to NCTM, who will then make the final revisions to the document."[1] The committee was not asked to take a position on the overall quality and validity of *PSSM*.

[1] Project Scope Statement, NRC Project No. MSEB-S-99-02-A
http://www4.nas.edu/webcr.nsf/ProjectScopeDisplay/MSEB-S-99-02-A

BACKGROUND

In October 1998, NCTM issued an initial draft of a revised standards document addressing content, teaching, and assessment in K-12 mathematics, *Principles and Standards for School Mathematics: Discussion Draft (PSSM)*. In all, 30,000 copies of *PSSM* were distributed. The draft was also posted on the Web where the document or sections of it were downloaded at a rate of 20,000 per month. NCTM initiated a comprehensive plan for soliciting comments on and reviews of the draft document, including commissioning 25 formal reviews from people with expertise in mathematics, statistics, mathematics education, educational policy and administration, and K-12 teaching. These formal reviews ranged from general reviews to those focused just on a particular grade band or topic. In addition, NCTM had created a Commission on the Future of the Standards responsible for overseeing the process of updating the original standards. In particular, the Commission requested other mathematics related professional associations, such as the Mathematical Association of America, the Institute for Operations Research and Management Science, and the Society for Industrial and Applied Mathematics, to form special review committees (Association Review Groups) to provide advice to the writers as they wrote the draft version of PSSM and to provide a review of the draft following its release. By May 1999, NCTM had received review comments from nearly 700 individuals and groups.

NCTM established an elaborate procedure for analyzing the review comments received. Since the comments were solicited using open-ended prompts rather than closed-form questionnaires, a qualitative research design was used to guide the analysis of responses. A categorization scheme was developed and responses were coded, using the paragraph as the unit of analysis. An iterative process was employed in which decisions were made at each successive iteration to add, delete, or merge categories in order to better capture the data. In total, eight major iterations were undertaken. Not all reviews submitted could be included in the analysis due to time constraints. However, all commissioned reviews (18), Associated Review Groups reports (10), NCTM Committee reviews (5), reviews by members of the NCTM Board and the NCTM Commission on the Future of the Standards (18), and reports from presentations at conferences or to other associations (19) were coded. Approximately 37% of the reports from other individuals or groups were randomly sampled. Furthermore, all of the reports received were scanned by the NCTM staff and any particularly thoughtful report was included in the analysis. In all, 297 reports were included in the analysis. The NCTM Commission on the Future of the Standards reviewed printouts of all data entered and synthesized these into 19 issues in five clusters: overarching issues, structure of the document, content issues, issues related to learning, and issues related to equity (see Appendix A).

THE REVIEW PROCESS

The NRC convened a Coordinating Review Committee (CRC) to review the process of revising the draft of *PSSM*. The 11 committee members were chosen for their expertise in mathematics, K-12 mathematics education, mathematics in the workplace, standards-based efforts to improve mathematics education, and business and industry.

Using the framework written by the Commission on the Future of the Standards, the NCTM/*PSSM* Writing Group prepared a document summarizing the major areas of concern identified by the field. This document presented the 19 broad issues, briefly discussed each issue, provided examples of the range of reviewer comments, and explained the NCTM/*PSSM* Writing Group's plan to address the comments. Prior to their first meeting on 1-2 June 1999, the Coordinating Review Committee (CRC) members received the discussion draft of *PSSM* and the document prepared by the NCTM/*PSSM* Writing Group describing how they planned to respond to the review.

At this initial meeting, the CRC discussed *PSSM*, the review process and the synthesis of review comments, each of the 19 issues identified, and the planned response to these 19 issues. The CRC members reacted to the planned NCTM response to each issue by making suggestions for improvements to the plan. Members of the NCTM/*PSSM* Writing Group and other representatives of NCTM were present during the open discussion session.

Generally, the CRC felt the NCTM/*PSSM* Writing Group had captured the essence of the reviewer concerns in their planned responses to the 19 issues. The committee, however, did make specific comments or recommendations on 10 recurring themes—identified by the reviews—that they wished to see addressed more thoroughly in the revision of the draft. In addition, in view of feedback from the reviewers, the committee added one other issue concerning the core and augmented curriculum they felt needed to be included. These reactions were presented to NCTM in an interim report, and the text is given below:

- **Vision**: members thought the vision needed to be more prominently identified within the document, more focused, and more succinct. (Issue #5)

- **Technology**: technology should be addressed and integrated into the Standards more fully. Its prospective and fundamental impact on the nature of mathematics study should be brought to the fore in the document. (Issue #15)

- **Student Disengagement**: members thought this issue should be addressed more explicitly in the document. (Issues #5, #17, #19)

- **Chapter 3**: members appreciated Chapter 3 and recommended retaining it but recognized that its information needed to be better integrated with the goals of the rest of the document. (Issue #8)

- **Chapter 8:** this chapter was troublesome to the members, as a fair bit of material was anticipated for that chapter but was unavailable at the time of the meeting. Members were anxious to review this chapter. (Issues #6, #19)

- **Document Configuration and Length**: members thought the configuration and length of the document were major issues e.g., grade bands for all standards? For only content standards? K-12 development in hard copy with grade band organization in electronic format? How to maximize the readability and usefulness of the document for busy classroom teachers? (Issues #7, #11)

- **Articulation**: members expressed some concern that the current structure of the Standards, namely in grade bands, inhibited the coherence of the Standards as students moved through the educational continuum and made it difficult for teachers to work together to retain the connections among grades. However, members realized that the electronic version of the document provided a valuable method to reconfigure the Standards for a variety of purposes. (Issue #13)

- **Core and Augmented Curriculum**: members did not think the concept of core curriculum for students with a range of abilities and aptitudes was covered explicitly in the document. What an augmented curriculum for better-prepared students might be was also missing. (Issues #17, #18, #19)

- **Examples**: the extensive use of examples that represented Standards in action at the different grade levels was strongly encouraged. Members will review examples at the final meeting to confirm that they are relevant, compelling, and real. (Issue #10)

- **Glossary**: members thought a glossary was needed for the document. (Issue #11)

During the summer of 1999, the NCTM/*PSSM* Writing Group prepared the final version of *PSSM*, taking into account the CRC comments and recommendations. They also prepared a response to the CRC interim report, describing and justifying their final actions on the issues. The CRC met again October 5-6 to review the revised draft of *PSSM* and to evaluate the adequacy and appropriateness of the Writing Group's response to the review comments and committee recommendations. The committee looked carefully at the revised *PSSM* considering each of the points discussed and identified at the first meeting.

Although, in general, the CRC was very satisfied with the NCTM/*PSSM* Writing Group's response to the CRC recommendations, the committee identified three points to reemphasize before the final version of *PSSM* went to press. These had been discussed at an open session with NCTM leaders and the NCTM/*PSSM* Writing Group. Based on the willingness evidenced

by the NCTM/*PSSM* Writing Group to address the previous issues raised by the CRC, the committee left the final disposition of these issues to the NCTM/*PSSM* Writing Group. These three points were summarized in a letter to the NCTM and the funding agency, the National Science Foundation. The three were:

- **Technology**: The committee agreed that the NCTM/*PSSM* Writing Group was extremely responsive to its requests to address and integrate technology more fully into the document and to bring to the fore the prospective and fundamental impact of technology on the nature of mathematics study. The committee found the treatment of technology throughout the document much improved from the October 1998 draft. Technology permeates the document and is presented in a balanced way in each grade band section. The committee felt that two statements in the revised draft, "Students can learn more mathematics more deeply with appropriate use of technology" and "The existence, versatility, and power of technology makes it possible and necessary to re-examine what mathematics students should learn as well as how they can best learn it" captured well the nature of the feedback and remaining concerns on the technology issues and encouraged the NCTM/*PSSM* Writing Group to revisit the wording of the technology principle to better express the spirit of these statements.

- **Core and Augmented Curriculum**: The committee agreed with the NCTM/*PSSM* Writing Group's stance that the "core" curriculum is constructed to be challenging for all students and rigorous enough to prepare all students well for college mathematics. However, the committee recommended that the NCTM/*PSSM* Writing Group attempt to communicate this more explicitly—to state that the mathematics in this core curriculum is strong enough to challenge all students, including those students preparing for college-level mathematics. The NCTM/*PSSM* Writing Group might also suggest additional formal and informal activities for students with particular interest in mathematics, including academic competitions, mathematics clubs, experiences in the workplace, special projects, and advanced placement courses.

- **Glossary**: The committee agreed that the NCTM/*PSSM* Writing Group was very responsive to the committee's recommendation to construct a glossary. However, the committee recognized that this was a more complex task than first thought because the document will have multiple audiences with a need for different explanations. Hence, the committee withdrew their earlier recommendation to include a glossary. The committee did recommend that the NCTM/*PSSM* Writing Group provide a list of acronyms in *PSSM* (e.g., CAS – computer algebra systems).

FINDINGS

The material prepared by NCTM for the review was well organized, clear, and thorough, and made the task of gauging the NCTM/PSSM Writing Group's responsiveness to the field reviews manageable. The central improvements in *PSSM* made as a result of the NRC review are described below.

- **Vision:** The issue of vision was identified by the reviewers as a major area of concern. The open review process established by NCTM brought in comments from many sectors expressing divergent points of view. On the basis of this input, the CRC encouraged NCTM to be bolder in their final version of *PSSM* and felt that the draft reviewed in September did in fact articulate a stronger vision. The vision of mathematics teaching in mathematics classrooms is now sufficiently compelling to create change and improvement and to sustain efforts over the next decade. Furthermore, the vision was created by responding to the comments from the field and was distilled into its current form through a process that has been thoughtful and deliberate. Following the CRC's recommendations, the current expression of the vision holds the document together with the vision laid out in chapter 1, the principles now permeating the rest of the document, and the vision connected back to Chapter 8 and tied in appropriate ways to implementation issues.

- **Chapter 3:** The use of the tables to organize student outcomes for both content and process aided in the reorganization of Chapter 3. The comments make it a summary that can stand alone, and the chapter grade bands follow the chart so there is coherence to the document. These changes reflects reviewers concerns about the role of Chapter 3.

- **Document Configuration and Length:** Although the document is long, the plan to make it a good reference document and to build subdocuments for administrators and other interested sectors of the education community, as asked by reviewers, will make it usable by different constituencies. The electronic version offers a way to restructure the document to ensure that articulation across both the content and process standards takes place. On-line access is not constrained by the linear structure of the print document, which will enable users to approach the document from different perspectives with different cuts through the grades or through the vertical strands.

- **Core and Augmented Curriculum:** Reviewers had noted that the draft document's treatment of core curriculum did not address the needs of special student populations. The core curriculum in the revised document is aggressive and inclusive, challenging for all students and yet preparing all students for university work. The content seems appropriate within the grade bands. Although there are many opportunities and ways to provide rich mathematically based experiences that are not part of the curriculum, these can be built into a program outside of the classroom. The vision and the curriculum as currently laid out are strong and provide for the development of this kind of activity.

- **Examples:** The NCTM/*PSSM* Writing Group revisited the examples, and the CRC feels the examples are greatly improved. Further, the NCTM is to be commended for bringing together experts from around the world to help develop examples and good technology applications. The NCTM/PSSM Writing Group strengthened the role and purpose of the examples by systematically cataloging each example to show how it fit.

- **Curriculum Balance:** The committee was pleased with the NCTM response to the issue of balance between skills and understanding. Conceptual understanding is not wholly reliant on skills. The committee agrees that it is important to acknowledge that students can have partial understanding while still weak in skills and should not be held back because of the deficiency in skills.

CONCLUSIONS

The CRC carefully reviewed the NCTM/*PSSM* Writing Group's revision process. The committee finds that the process established by NCTM to solicit comments from the field to be commendable and the process established by them to analyze those comments exemplary. The CRC also finds the NCTM's response to the issues identified from the comments to be both adequate and appropriate.

The committee believes that carefully developed educational standards are a critical tool in promoting systemic educational improvement. The 1989 standards for mathematics began a discussion among educators about what was important in content, teaching, and assessment in mathematics. The learning process is a continuum, not only for students but for those effecting the desired change. As such, the committee is hopeful that NCTM/*PSSM* will serve not only to create a renewed vigor for improving the educational process but also to stimulate the environment for continued conversation by the community.

Appendix A

Issue	OVERARCHING ISSUES
1	Who is the audience and what is the purpose of the document? a. Who is the audience? b. What is the purpose? c. How are the audience and purpose connected?
2	In what ways should the document be more specific in its recommendations? a. Should there be benchmarks? b. Should topics and their sequence be specified for each grade? c. Should content be prioritized? d. How should the issue of specificity be handled in the process standards?
3	What global views of mathematics and of mathematics education should be espoused in the document?
4	What dependencies should there be between the previous standards documents and *PSSM*? a. Is *PSSM* intended to be a stand-alone extension of the previous three standards documents? b. Does *PSSM* extend the existing standards documents?
5	Is the vision for school mathematics sufficiently clear and strong to sustain change over the next decade?
6	Are the needs of teachers addressed? a. Are support and resource issues sufficiently addressed? i. Time ii. Resources (texts, technology) iii. Professional development iv. Parents, policymakers, and other stakeholders b. Has teachers' knowledge of content been taken into consideration? i. All teachers ii. Specialists

Issue	STRUCTURE OF THE DOCUMENT
7	How can a more holistic view of classroom instruction be presented that incorporates the process and content standards and the guiding principles? a. How can assessment have a greater profile in the document? b. Where is the explicit evidence that the principles guided the writing of the standards? c. How can the process standards be interwoven into the content standards? i. Which should come first in the discussion, the content or the process standards? ii. Should the process standards be discussed separately in the grade-band chapters?
8	What should be the role of chapter 3? a. Should it be eliminated? b. Should it be shortened or reformatted as a part of an executive summary?
9	How well is research being used to document claims being made? a. Are the research citations helpful? b. Is the best available evidence cited when needed? c. Is research evidenced interpreted correctly?
10	What is the role of examples? a. What is the purpose of examples? i. Is there a clear reason for the inclusion of examples? ii. Are the vignettes serving the purpose intended? iii. Is the reason made clear to the reader? iv. Are there sufficient connections across standards? b. Is the variety of examples sufficient? i. Is there a balance of contexts, including real-world examples? ii. Is there a variety of students used in the examples? iii. Is there a variety of mathematical content? iv. Is there a variety of mathematical tools used in the examples? c. Is the quality of examples compelling? i. Are they fresh? ii. Are they contrived? iii. Are they distracting?
11	How can the document be made easier to read, with correct and appropriate terminology? a. Will the audience understand all the technical words? b. Are some words used unclearly or as educational jargon? c. Are some words used incorrectly? d. Should there be a glossary? e. What additional editorial attention is needed? i. Wordiness, length? ii. Passive/active voice? iii. Complexity? iv. Single voice?

Issue	CONTENT ISSUES
12	Are the connections within mathematics addressed adequately? a. To what extent might the systematic use of unifying mathematical themes structure grades K–12 mathematics? b. Should the connections among the content standards be made more explicit? c. Should the connections within a content standard be made more explicit?
13	How well is articulation across the grades handled? a. How well was the articulation across the content standards handled? b. How well was the articulation across the process standards handled?
14	Is the content appropriate for students in the specified grade bands? a. Is the content in grade pre-K–2 appropriate? b. Is the content in grades 3–5 appropriate? c. Is the content in grades 6–8 appropriate? i. How much formal algebra should be included? d. Is the content in grades 9–12 appropriate? i. Should calculus be a part of the high school curriculum?
15	Is the role of technology sufficiently addressed? a. What is the relation to paper-and-pencil computation? b. Has the power of technology to transform the curriculum been adequately treated? c. Is the balance between the promise and limitations of technology appropriate? d. Should more attention be given to technology? e. What are the main messages about the use of technology?
Issue	**ISSUES RELATED TO LEARNING**
16	Should particular educational theories be promoted explicitly in the document? a. Should there be more attention to learning theory? b. Should constructivism be explicitly referenced? c. Should the van Hiele model be explicitly referenced?
17	Has the correct balance been struck between skills and understanding? a. Does the document go too far in emphasizing skills? b. Is the document clear in its interpretation of "computational fluency"? c. Does the language used to discuss single-digit arithmetic convey the proper balance between skills and understanding? d. What should the relationship be between invented and conventional algorithms? i. How are the timing of algorithm use and the flow across grades to be orchestrated? ii. How do nonconventional (e.g., "low stress") algorithms fit in? iii. Has the importance of estimation skills been emphasized sufficiently? e. What is the relationship between computational proficiency and technology?

Issue	ISSUES RELATED TO EQUITY
18	How can the document better address the needs of special student populations? a. Can the document clarify if and how the curriculum should vary to meet the differing needs of various groups of students? b. Can the document clarify how instruction should vary to meet the differing needs of various groups of students?
19	Is the issue of equity addressed clearly and throughout the document? a. Is there sufficient direction given for different audiences? b. Is the language used to describe equity issues clear? c. What is the relationship of equity to the other principles and standards?

Appendix B

Committee Biographies

- **James Serum,** *chair***,** is currently Executive Vice President and Chief Operating Officer of Viaken Systems, Inc. Prior to this he was general manager for Advanced Sensor Products at Hewlett Packard Corporation. He received a B.A. in chemistry from Hope College and was awarded a Ph.D. in organic chemistry in 1969 from the University of Colorado. His doctorate research was directed toward studies in Mass Spectrometry. Following his graduate studies, he taught and did research at the University of Ghent, Belgium.

- **Isaac Abella** is a professor of physics at the University of Chicago. His field is non-linear optical physics, ultrafast transient phenomena, and laser interactions in atoms and ions in solids. He received his Ph.D. in physics from Columbia University, where he worked under Professor Charles H. Townes. He has served as member of the Education Committee of the American Physical Society (APS); chair of the Education Committee of the Laser Science Topical Group of the APS; chair, Isaakson Prize Committee, APS; and member of the National Science Content Standards Working Group of the National Research Council. He is a fellow of the APS and of the Optical Society of America and president of the Chicago Chapter of Sigma Xi. He was awarded the Quantrell Prize for Excellence in Undergraduate Teaching at Chicago.

- **Anne Bartel** is a 30-year teacher with the Minneapolis Public Schools who has K-12 experience in mathematics teaching. For the past 5 years she has been the Mathematics Project Manager at SciMathMN, a statewide public/private partnership that advocates and supports standards-based systemic improvements in the teaching and learning of K-12 science and mathematics. SciMathMN works to increase the educational achievement and participation of all Minnesota students in science and mathematics by promoting standards-based policy and professional development and practice, and by increasing public awareness and engagement. As part of her work with SciMathMN, she has been the lead author on the Minnesota mathematics curriculum framework. Ms. Bartel is also immediate past president of the Minnesota Council of Teachers of Mathematics

- **Andrew Gleason** is professor emeritus of mathematics at Harvard University. His research has focused on topological groups and Banach algebras. He is a member of the National Academy of Sciences, the American Mathematical Society, the Mathematical Association of America, the American Philosophical Society and the American Academy of Arts and Sciences, among others.

- **Thomas Romberg** is a professor in the Curriculum and Instruction Department in the School of Education at the University of Wisconsin, Madison. He was chair of the NCTM 1989 Commission on Standards for School Mathematics. He received his Ph.D. from Stanford University in 1967. His areas of interest include the learning of mathematics; methods of assessing and evaluating both students and programs; integration of research on

learning, teaching, and curriculum, and mathematics curriculum reform efforts. His recent publications include *Mathematics Classrooms that Promote Understanding* (1999), *Reform in School Mathematics and Authentic Assessment* (1995), *Integrating Research on the Graphical Representation of Functions* (1993), and *Mathematics Assessment and Evaluation* (1992).

- **Eric Slud** is a professor of mathematics at the University of Maryland, College Park, where he has taught in the Statistics Program since 1976. He has been director of the Statistics Program from 1989 to 1992 and initiator of and advisor in actuarial studies since 1985. His research has primarily concerned statistical inference from clinical trials and from stochastic process data involving survival times or time series. He has published more than 45 research articles in refereed professional research journals in probability and statistics and in applications including biomedical trials, software reliability, remote sensing, actuarial science, and the decennial census. His research has been supported by the Office of Naval Research, the Air Force, and the National Institutes of Health, and he was an American Statistical Association and Census Fellow in 1997-98. Dr. Slud received a B.A. in mathematics from Harvard College in 1972 and a Ph.D. in mathematics from MIT in 1976.

- **John T. Snow** is Professor of Meteorology and Dean of the College of Geosciences at the University of Oklahoma. His current professional interest is in Earth System Science, the integration of the best available knowledge from the Earth and Life Sciences to provide a holistic picture of "how the world works". His research interests include the dynamics of columnar vortices, ranging in scale from small dust devils to tornadoes, meteorological instrumentation and observing systems, and simple numerical modeling of the Earth System. Dr. Snow has had a long-standing interest in education at all levels. He participated in the writing of the National Science Education Standards, and has written or contributed to numerous articles for teachers, students, and the general public. He has led several projects promoting an Earth Systems Science approach to Earth Science education for K-12 teachers and university undergraduates. He is currently serving on the education and human resources committees of the American Geophysical Union and the American Institute of Physics. He received his Ph.D. in atmospheric sciences from Purdue University.

- **Judith Sowder** is a professor of mathematical sciences at San Diego State University and the director of the Center for Research in Mathematics and Science Education (CRMSE) beginning Fall of 1998. She also serves as editor for *The Journal for Research in Mathematics Education*. For several years she studied the development of number sense and estimation skills in school-age students. As a co-director of the National Center for Research in Mathematical Sciences Education from 1990-1995 she directed a national working group and a local research project on the learning and teaching of middle school number and quantity. She also directs an NSF project to develop materials to strengthen the mathematics preparation of prospective and practicing elementary and middle school teachers, and an NSF Graduate Traineeship project.

- **Adria Steinberg** is a program director of Jobs for the Future (JFF), a national non-profit organization working to enhance economic security and access to opportunity for all individuals by strengthening the transitions and linkages between learning and work. In her work with schools, districts, and communities, Ms. Steinberg focuses on bringing authentic problems, real-world standards, and adult mentors into the center of teaching and learning, and on using school-to-work strategies to revitalize and transform high schools. Ms. Steinberg brings to this work 30 years of experience in the field of education—as a teacher, staff and curriculum developer, writer, and most recently, as the academic coordinator of the Rindge School of Technical Arts in Cambridge, MA, where she co-directed the award-winning CityWorks program and the federally-funded Vocational Integration with Academics (VIA) project. She has authored numerous publications, and, for five years, was the writer/editor of *The Harvard Education Letter*.

- **Marcia P. Sward** joined the staff of the National Environmental Education & Training Foundation in February 2000, as Senior Director of the Education & Environment Program. Prior to this, she served for over ten years as executive director of the Mathematical Association of America (MAA). During this time, she was a member of the Joint Policy Board for Mathematics (JPBM), the joint organization through which the MAA, the American Mathematical Society (AMS), and the Society for Industrial & Applied Mathematics (SIAM) carry out many of their public information and government relations activities. She also served on the Board of Directors of the Council of Engineering and Scientific Society Executives. Dr. Sward was the founding executive director of the Mathematical Sciences Education Board (MSEB) of the National Research Council. She taught mathematics at Trinity College in Washington, DC, for ten years. She received her Ph.D. in mathematics from the University of Illinois, Champaign-Urbana.

- **James W. Wilson** is professor of mathematics education at the University of Georgia. He served as department head from 1969 to 1993. He is a member of the MAA, NCTM, AERA, and the National Society for the Study of Education, among others. He was a member of the NCTM writing team for *Assessment Standards for School Mathematics* from 1994-1995 and editor of the *Journal for Research in Mathematics Education* from 1976-1982. He has authored numerous articles related to mathematics learning. Dr. Wilson received his Ph.D. in mathematics education from Stanford University.