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ABSTRACT

This document contains 13 papers from and about a working conference on adult mathematical literacy. The following papers are included: "Preface" (Iddo Gal, Mary Jane Schmitt); "Summary of Conference Discussions" (Iddo Gal et al.); "Reflecting about the Goals of Numeracy Education" (Iddo Gal); "Needed Skills and Skills Gaps: Adult Numeracy Demands, Abilities and Instruction" (Larry Mikulecky); "Comparison of Literacy to Numeracy Achievement in a Life-Skills Context" (Patricia Rickard, Richard Ackermann); "Federally Supported Adult Education Delivery System" (Division of Adult Education and Literacy, U.S. Department of Education); "Can the Delivery System Deliver? Realities of Numeracy Education in Adult Literacy Programs" (Iddo Gal); "Issues and Barriers in Workplace Numeracy Education" (Mary Ann Shope, Gretchen Watson); "Adult Basic Education Math Instruction--Massachusetts Practitioners' Viewpoints on the ABE (Adult Basic Education) Learner and the Instructional Environment" (Esther D. Leonelli, Ruth Schwendeman); "Exploring What Counts: A Summary Report of Research into ABE Math in Massachusetts" (Bonnie B. Mullinix, John P. Comings); "NCTM (Teachers Council of Teachers of Mathematics) and Change in Mathematics Education" (Peter Kloosterman); "Lessons Learned?" (Mary Montgomery Lindquist); and "The ABE Math Standards Project: Adapting the NCTM Standards to Adult Education Environments" (Mary Jane Schmitt). Many papers contain substantial bibliographies. Appended are the following: conference agenda; "calculator debate" activity; guidelines for contacting the Adult Numeracy Practitioners Network; and list of conference participants. (MN)

Proceedings

Conference on Adult Mathematical Literacy

March 20-22, 1994
Arlington, Virginia

Co-sponsored by

National Center on Adult Literacy
National Council of Teachers of Mathematics
Office of Vocational and Adult Education
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Proceedings

Conference on Adult Mathematical Literacy

Editors:

Iddo Gal
Mary Jane Schmitt

Produced by:

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Conference on Adult Mathematical Literacy

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Sponsors

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The Conference was Endorsed by:

American Association for Adult and Continuing Education
American Mathematical Association of Two Year Colleges
Correctional Education Association
Comprehensive Adult Student Assessment System (CASAS)
GED Testing Service
Laubach Literacy International
Literacy South
Literacy Volunteers of America
Mathematical Association of America
National Adult Education Staff Development Consortium
National Adult Education Professional Development Consortium
National Alliance of Business
National Association of Developmental Education
National Association of State Adult Education Directors
National Center for Research in Mathematical Sciences Education
National Institute For Literacy
World Education

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Preface

The Working Conference on Adult Mathematical Literacy, which took place on March 20-22, 1994, in Arlington, Virginia, was co-organized by the National Council of Teachers of Mathematics, the National Center on Adult Literacy at the University of Pennsylvania, and the Office of Vocational and Adult Education of the United States Department of Education. This invitational Conference aimed to take a first step towards ensuring that all adults in the U.S. can acquire mathematical skills they may need to function on the job and in society, to achieve their personal goals, and to support their children's education.

This preface explains the process that led to convening this conference, describes the working process of the conference, and briefly overviews the Summary of conference discussions and the eleven background chapters included in these Proceedings in addition to the Summary. (Draft versions of these chapters were sent to all conference participants as pre-conference readings. Readers of these Proceedings are encouraged to consult the chapters for more background information on specific issues mentioned in the Conference Summary).

Origins

The Board of Directors of the National Council of Teachers of Mathematics (NCTM), in response to a request from some of its members who work in the field of adult basic education, appointed in 1992 a Task Force on Adult Mathematical Literacy to investigate the possibility of a conference. The Board agreed to support a conference if the task force would find adult education organizations to co-sponsor the event. The National Center on Adult Literacy (NCAL) at the University of Pennsylvania, having already begun in 1991 its Numeracy Project and seeking to promote adult numeracy education, was interested in co-organizing a conference with NCTM. The U.S. Department of Education's Office of Vocational and Adult Education (DOE/OVAE) offered encouragement and substantial support. Several other organizations endorsed the conference (see enclosed list).

Participants

Of the 110 invited participants, about half were adult educators directly involved in numeracy-related instruction, teacher training and curriculum development in GED, ABE, ESL, and workplace literacy programs in over 30 states. The remaining participants included representatives from the mathematics education and adult education communities nationwide, and from federal agencies, non-governmental organizations, business, educational media, academia, and the endorsing organizations. The names and affiliations of participants are listed in Appendix D.

Working Process

The meeting format combined formal presentations with work in small groups. Formal presentations were arranged in order to enable people coming from different communities (e.g., mathematics education, adult education, federal agencies, publishing) to learn about and update their understanding of the many issues involved in promoting adult mathematical skills, and thus join the discussions on an equal footing. Work in small groups, which occupied about two thirds of the conference time, aimed to maximize the time each participant had to exchange information and ideas, to raise concerns and identify problems and needs, and to make preliminary suggestions for improving adult numeracy education. After each presentation, participants discussed pre-assigned questions in small groups, and met together only in reporting sessions at the end of each day. Each group had an assigned facilitator and recorder; participants, facilitators and recorders rotated several times in different groups. Participants helped shape the content and format of the third day of the conference, when small groups reflected on topics that emerged in the first two days and worked to create tentative recommendations.

A word about terminology. Some people prefer to use the term "mathematical literacy," believing that "numeracy" is too vague or limiting in scope. Others feel just the opposite, taking "numeracy" to be the mirror image of literacy, and thus a broad concept, while viewing "mathematical literacy" only as a sub-area of mathematics. To avoid unnecessary debate, the two terms are used interchangeably in these Proceedings. In general, both terms should be viewed as loosely referring to the aggregate of skills, knowledge, beliefs, and habits of mind, and related communicative and problem-solving skills, which individuals may need to effectively handle real-world quantitative situations, problems, and interpretive tasks with embedded mathematical elements.

The Summary of Conference Discussions

The Summary synthesizes discussion notes provided by recorders and participants in each of the small groups, and aims to reflect in a concise way the range of pertinent perspectives and ideas that emerged. It is important to note that points of view in the conference Summary should not be viewed as official "findings" or "recommendations" of the conference; no process was used to secure agreement or endorsement from all participants, not only because of time constraints, but also because the intent of the conference was to initiate an examination of issues that would inform dialogue and further action among the professional communities represented in the conference.

The Background Chapters

These eleven chapters are grouped into three clusters: Needed Skills and Skill Gaps, Current Delivery System, and Reform Initiatives in Mathematics Education. As mentioned above, draft versions of these chapters were sent to conference participants to frame key dilemmas, needs, or processes in this complex system of adult education and mathematics education, and to provide up-to-date background information in areas with which some participants (or readers of these Proceedings) may be unfamiliar. Authors were asked to write concise and pragmatic papers not exceeding eight pages in length, to ensure that chapters are accessible and useful to diverse audiences. To enable easy navigation through chapters, each chapter begins with a Purpose section briefly explaining the key questions or information the paper addresses, and ends with an Implications section framing issues or questions which should be considered by conference participants and by readers of the Proceedings.

Section 1—Needed Skills and Skill Gaps. Chapters in this section raise questions about target skills which numeracy education should address, and whether current skill levels are satisfactory. Iddo Gal (Ch. 1) explores what numeracy skills adults may need to possess, and highlights some of the tensions involved in defining the goals of numeracy education. Larry Mikulecky (Ch. 2) discusses mathematical skills needed in workplace contexts, and reviews unpublished findings from the National Adult Literacy Survey (NALS) which are specific to employment issues. Patricia Rickard and Richard Ackerman (Ch. 3) present data from the Comprehensive Adult Student Assessment System pertaining to functional numeracy skills of participants in adult literacy and job preparation programs. (Conference participants also discussed the NALS report and how the functional skills assessed by its scales, especially the Document and Quantitative literacy scales, relate to traditional skill areas addressed by mathematics educators).

Section 2—Current Delivery System. The five chapters in this section highlight various realities and gaps in adult math/numeracy education in key adult education contexts. In Chapter 4, members of the Division of Adult Education and Literacy (U.S. Department of

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Education) review the key adult education programs administered by the Department of Education and their funding sources, and comment on the role of mathematics education for adults in such programs. Iddo Gal (Ch. 5) raises questions about the nature of math-related activities in adult literacy programs, and presents results from a national survey of the extent of math-related activity, staff preparation, assessment, and the use of technology in literacy programs in the U.S. Esther Leonelli and Ruth Schwendeman (Ch. 6) describe key learning contexts (e.g., GED, ABE, ESL) in adult mathematics education and frame questions and dilemmas regarding math education in such contexts as seen from the program/practitioner point of view.

Mary Ann Shope and Gretchen Watson (Ch. 7) outline realities, problems and needs which emerge in workplace numeracy programs, and discuss some of their implications for adult educators and service providers. Finally, Bonnie Mullinix (Ch. 8) reviews recent results from the Research in Adult Basic Education in Mathematics Project, which looked into characteristics of students, teachers, instructional resources and learning environments in Massachusetts.

Section 3—Reform Initiatives in Mathematics Education. Peter Kloosterman (Ch. 9) reviews reform efforts that the National Council of Teachers of Mathematics (NCTM) has spearheaded in recent years, outlines the three key documents which NCTM issued (Curriculum Standards, Professional/Teaching Standards, Assessment Standards), and provides some illustrative examples for their implications for changing classroom practices. Mary M. Lindquist (Ch. 10), past-president of NCTM, explores issues and barriers that NCTM encountered in its attempts to implement the Standards in K-12 schools, and highlights their implications for future reform initiatives in *adult* education. Mary Jane Schmitt (Ch. 11) summarizes a recent effort to adapt the NCTM Standards for adult mathematics education in Massachusetts, and outlines issues that arose as teachers and adult students attempted to implement new instructional frameworks.

While the NCTM reform initiatives were the focus of chapters in this section, two other recent noteworthy efforts should be recognized. Both Kloosterman (Ch. 9) and Mikulecky (Ch. 2) mention important work by the Secretary of Labor's Commission on Achieving the Necessary Skills (SCANS) and explore some implications of workplace requirements for adult mathematics education. Also, Marilyn Mays, President of the American Mathematical Association of Two Year Colleges (AMATYC), gave a conference presentation on AMATYC's recent initiative to define curricular goals for developmental and remedial mathematics courses in colleges, and pointed to possible links between this initiative and future reforms in adult numeracy education.

Outcomes

We must realize that this conference, while exciting in and of itself, is not likely to have lasting impact on the field of adult numeracy education unless it becomes a first step in a reform process. Clearly, the complexity of topics involved in improving adult numeracy provision has defied any quick closure during the conference itself. (One immediate outcome of the conference has been the establishment of the Adult Numeracy Practitioner Network; see Appendix D for information on how to join the Network). We hope that the suggestions for "next steps" included in the Summary and the information included in the background chapters (especially in the Implications sections), would enable members of the adult education and mathematics education communities to continue a dialogue and plan further actions that will contribute to improving numeracy skills of adults in the United States.

Iddo Gal
Mary Jane Schmitt

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Acknowledgments

Many people and organizations were involved in making the Conference on Adult Mathematical Literacy a reality.

We would like to extend our special thanks to members of the Conference Committee, Cheryl Cleaves, Esther Leonelli, Myrna Manly, and Dean Priest, for their efforts in organizing and executing the conference.

For providing continuing support to the NCTM task force on Adult Mathematical Literacy, and for providing financial support for the conference, we thank the Executive Board of the National Council of Teachers of Mathematics. Special thanks go to Mary Lindquist and Jim Gates for their commitment and guidance, and to Cathy Petty for logistical assistance.

We appreciate the encouragement of Ron Pugsley and the financial support of the Office of Vocational and Adult Education of the United States Department of Education, and are thankful to Mike Dean and his colleagues from OVAE for contributing to the writing of chapter 4 in the Proceedings.

Many thanks go to the National Center on Adult Literacy and to its director, Daniel Wagner, for supporting the conference and for its on-going commitment to adult numeracy education.

We also thank the seventeen endorsing organizations for their support.

The working groups on Day 2 of the conference were skillfully facilitated by Cheryl Cleaves, Donna Curry, Myrna Manly, Joyce Harvey Morgan, Bonnie Mullinix, Dean Priest, and Sally Waldron, who also made useful suggestions for formulating the questions on which these groups focused.

Members of the NCAL Numeracy Project have spend many hours working on the conference summary. Jocelyn Reed has provided valuable assistance in transcribing the notes submitted by all working groups. Jennifer Danridge, Lynda Ginsburg, and Ashley Stoudt have worked diligently to synthesize the various suggestions and recommendations and on editing and revising successive drafts. We also thank Rose Steiner for her valuable suggestions and editing.

Many of the teachers who came to the conference from more than 30 states received travel assistance from their programs or state agencies to supplement funding from the conference co-organizers. We thank these organizations for making it possible for practitioners to attend the conference.

Finally, we wish to thank the conference participants, who contributed to its success by sharing their knowledge, concerns, and insights on adult learning and mathematics education. In addition to the teachers who were selected to participate, more than a hundred additional teachers who expressed interest in the conference not included due to space and logistical constraints. We thank these and other practitioners for sharing with us their interest in the improvement of adult numeracy education and for providing a compelling reason to establish a numeracy network to continue to build on the foundations that were laid at the conference.

Contributors

Richard Ackerman is a Research Assistant at CASAS (Comprehensive Adult Student Assessment System) and is involved in research and development of adult assessment methods.

The *Division of Adult Education and Literacy* of the Office of Vocational and Adult Education, U.S. Department of Education, oversees numerous programs and initiatives in adult education.

Iddo Gal is Director of the Numeracy Project at the National Center on Adult Literacy, and a Research Assistant Professor at the Graduate School of Education, University of Pennsylvania.

Lynda Ginsburg is Research Coordinator of the Numeracy Project at the National Center on Adult Literacy, She has taught mathematics for over 15 years in various K-12 and adult education contexts.

Peter Kloosterman is Associate Professor of Mathematics Education at Indiana University, where he works with elementary and secondary preservice and inservice teachers. He has worked with several industry-based adult numeracy programs and with high school Tech Prep programs. He is currently Associate Editor of the *Journal for Research in Mathematics Education.*

Esther Leonelli is a member of the Massachusetts ABE Math Team and co-editor of *The ABE Math Standards Project, Volume I: The Massachusetts Adult Basic Education Math Standards* (1994). She teaches ABE and GED math classes and coordinates an education program for homeless adults.

Larry Mikulecky is Professor of Education at Indiana University. For the past 15 years his research has examined basic skills in the workplace, adult basic educe ion, and school to work transitions. His current projects include analyzing National Adult Literacy Survey data for employed adults, and designing instructional strategies for implementing SCANS guidelines .

Mary Montgomery Lindquist is past-President of the National Council of Teachers of Mathematics, Vice-Chair of the Mathematical Sciences Education Board, and chair of the Alliance for Curriculum Reform. She is a Professor of Mathematics Education at Columbus College, Columbus, Georgia.

Patricia Rickard is Executive Director of CASAS (Comprehensive Adult Student Assessment System), where she directs adult basic skills assessment, curriculum management, and evaluation systems nationwide for ESL, job training, Even Start, family literacy, and other adult learning programs. She also manages research contracts for California's Department of Education.

Mary Jane Schmitt is Co-Director of The Massachusetts ABE Math Standards Project. She is on the staff of the Massachusetts State Systemic Initiative (Project PALMS- Partnerships Advancing the Learning of Mathematics and Science). She is committed to increasing mathematical, scientific, and technological literacy for adult learners.

Ruth Schwendeman is a member of the Massachusetts ABE Math Team and co-editor of *The ABE Math Standards Project, Volume I: The Massachusetts Adult Basic Education Math Standards* (1994). She is a workplace educator and consultant/trainer in teaching critical thinking skills.

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Summary of Conference Discussions

Iddo Gal
National Center on Adult Literacy

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Ashley Stoudt and Lynda Ginsburg
National Center on Adult Literacy

Outline

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I. Overview

The following provides background information and a summary of three days of discussions which took place at the Conference on Adult Mathematical Literacy, held in Arlington, Virginia, on March 20-22, 1994.

This invitational working conference aimed to take a first step towards ensuring that all adults in the U.S. can acquire mathematical skills they may need to function on the job and in society, achieve their personal goals, and support their children's education. Specific goals of the conference included:

- To identify issues contributing to the lack of mathematical literacy skills in the adult population, and to assess the capability of the current adult education system to handle the challenge of improving numeracy skills;
- To examine reform movements in mathematics education that can serve as a basis for changing adult numeracy education;
- To initiate plans for action at the national, state and local levels, which would incorporate perspectives of members of the mathematics education and adult education communities, and of all other stakeholders involved in adult education;
- To create a grassroots network of practitioners interested in reforming mathematics instruction in adult literacy education.

The 110 participants represented the spectrum of interest and involvement in adult numeracy education, and included adult educators directly involved in math-related instruction, teacher training and curriculum development, mathematics educators working in K-12 and post-secondary contexts, and representatives from federal agencies, non-governmental organizations, business, educational publishing, academia, and the endorsing organizations. Given the range of participants' backgrounds and expertise, reading materials were provided and presentations and other activities on specific topics were planned to create a foundation of shared knowledge upon which the conference discussions could build. (Chapters 1-11 in the Proceedings summarize the content of presentations and the pre-conference reading materials). On Days 1 and 2, each presentation or activity (see below) was followed by small group discussions which focused on specified questions. On Day 3, topics that emerged in the first two days were revisited and working groups made preliminary recommendations for future action. This Summary synthesizes discussion notes provided by recorders, facilitators and participants in each of the groups.

Points of view in this Summary should not be viewed as official "findings" or "recommendations" of the conference, as no process was used to secure agreement or endorsement from all participants. Most work occurred in small groups, with all participants meeting together only in reporting sessions at the end of each day. The intent of the conference was to raise and examine issues; this Summary reflects the range of pertinent perspectives and ideas that emerged.

II. Adult numeracy practitioners begin to network

The first day of the conference was attended by sixty adult basic education teachers and teacher trainers (selected through an application process to represent over 30 states) and by members of the conference committee, who gathered to get acquainted with one another, and to share information about the successes and challenges in their mathematics/numeracy programs. The agenda for Day 1, and networking activities on subsequent days, were designed with the hope that these participants would form the initial core of a national numeracy practitioners network.

Welcoming remarks. Members of the Conference Committee were joined by Ron Pugsley, Acting Director of the U.S. Department of Education's Office of Vocational and Adult Education, in welcoming the participants.

Exchange regarding regional activities and challenges. The participants were grouped by geographic region to share information about what math-related activities were happening in each of the following topic areas: workplace-specific initiatives, staff development, assessment, technology, curriculum, instructional practices and materials, and specific populations (e.g., Learning Disabilities, English to Speakers of Other Languages, etc.) Participants then regrouped by topic area to compile information about that topic across regions.

The calculator debate. Myrna Manly (CA) and Marty Gilchrist (VA) conducted a stimulating discussion addressing the question of how and in what contexts calculators should be used in adult numeracy classes. This question has implications for instruction, assessment, and curriculum planning, and it ultimately should affect staff development programs. Participants were presented with a continuum offering five possible approaches to the use of calculators, ranging from not allowing calculators at all in classes, to exclusive use of calculators (rather than paper-and-pencil computations). The description of each approach (see Appendix A) included both the beliefs about how and why calculators should be used, as well as the actual classroom practices that the approach suggests. Participants first selected the approach which describes the current level of calculator use in their programs or classrooms; next, participants "voted" on their "ideal" approach for future use of calculators in practice and graphs depicting their opinions were displayed.

Few participants placed themselves at the extreme ends of the scale (i.e., radically against calculator use, or for exclusive use of calculators); most participants reported a moderate level of usage of calculators in present classrooms. However, a majority shifted toward greater use of calculators in the future. Participants attributed the apparent gap between current and desired usage of calculators to several factors, including that calculator usage is not allowed on (standardized) tests, that teachers receive little training in the pedagogy of calculator usage, or that it is unclear how instruction in calculator usage will affect the learning of regular computational skills. Overall, a debate about calculator usage served to illustrate the interactions among different aspects of the "system" (i.e., instruction, assessment, curriculum planning, needed staff development) and highlighted the complexities involved in introducing a change in instruction.

Innovative K-12 programs of interest to adult numeracy educators. Donald Chambers (National Center for Research in Mathematical Sciences Education, University of Wisconsin, Madison) presented "Maths in Context: A Connected Curriculum for Grades 5-8," a program based on a curriculum originally developed in the Netherlands that embeds all skills instruction within realistic situations. Later on, Virginia Thompson from the Lawrence Hall of Science (University of California, Berkeley) discussed Family Math, a nationally renowned program that creates opportunities for parents and children to engage in mathematical learning together.

III. Examining challenges and realities in the current system

The second day of the conference brought in additional stakeholders involved in policy, planning or dissemination at the federal and state levels; and in research, development, and training in the areas of mathematics or adult education in academic institutions. To initiate a discussion about the present realities and challenges of mathematical literacy education for adults, the following three questions were presented:

1. ***What numeracy skills do adults need, and are there gaps between needed and existing numeracy skills?***

2. ***What are the characteristics of the delivery system involved in adult numeracy education? and,***

3. ***What implications may recent reform efforts in mathematics education (e.g., at the K-12 level) have for adult numeracy education?***

Needed skills and skill gaps. Larry Mikulecky (Indiana University) discussed the findings of the Secretary of Labor's Commission on Achieving Necessary Skills (SCANS) and the implications of the SCANS reports for shaping numeracy education for adults, especially with regard to job preparation. Patricia Rickard (CASAS; California Adult Student Assessment System) reported data about literacy and numeracy skills of participants in adult education programs in California and other states.

[Editorial Note: Additional details about SCANS recommendations and their implications for instruction appear in two Proceedings chapters, by Mikulecky and by Kloosterman. To complete these discussions, it should be noted that many of the workplace competencies highlighted by SCANS as critical in high-performance workplaces involve *integrative* mathematical problem-solving; yet, these competencies often do not fit neatly under traditional subject areas in mathematics. For example, SCANS points to Resources (e.g., scheduling time, planning a budget, managing personnel, planning and managing the use of materials or supplies) as a critical competency area for workers at *all* levels; competencies regarding "time" could involve, e.g., planning one's own time, coordinating schedules of several people, creating a timeline for project completion, and more. SCANS does not recommend that such competencies be taught separately, but as parts of long and short term projects which involve both individual and group effort.]

Current delivery system. Jim Parker (Office of Vocational and Adult Education, U.S. Department of Education) reviewed the federal perspective on adult education and on mathematics education for adults. Iddo Gal (National Center on Adult Literacy) reported on the current state of numeracy provision in ABE programs nationwide, based on a national survey. Bonnie Mullinix (World Education, Boston), discussed results from recent research into the nature of mathematics education for adults in Massachusetts.

Reform efforts in mathematics education. Mary Jane Schmitt (Massachusetts Department of Education) and Barbara Goodridge (Lowell Adult Education Program, MA) presented the inquiry project of the Massachusetts ABE Math Team, a group of practitioners who investigated and adapted the National Council of Teachers of Mathematics (NCTM) Curriculum Standards to adult education contexts. Mary Lindquist (president of NCTM) discussed the NCTM curricular and teaching standards and reviewed lessons learned by NCTM in its attempts to push for their implementation in schools. Marilyn Mays (president of the American Mathematical Association of Two-Year Colleges, AMATYC) discussed efforts to develop standards for developmental mathematics courses in two-year colleges.

Based on discussions of recent findings from the National Adult Literacy Survey, of data from the CASAS assessment system (which is used in several states), and of participants' experiences with teaching mathematics to adults in various contexts, it became apparent that mathematical skill levels of adults have much room for improvement. The complex and overlapping perspectives that were raised in response to question 1 (skills and skill gaps) and question 2 (the current delivery system) are grouped below under two headings: Issues specific to math/numeracy instruction of adults, and general aspects of the adult education system which also affect math/numeracy instruction. Responses to question 3 (reform efforts) and other points of view raised later in the conference about needed changes in the system are discussed later in part III of this Summary.

1. Numeracy education aspects of the current system

In examining factors affecting adult learners' acquisition of math/numeracy skills, participants pointed to numerous forces or realities which operate separately or in combination and which should be kept in mind in considering the future of adult numeracy education.

a. Diversity in the classroom. The classroom contexts in which adults learn mathematics are complex and diverse. Both *students* and *teachers* bring with them diversity in prior mathematics experience and in world knowledge, as well as differences in linguistic and cultural backgrounds. Not all students share the same goals for learning; students may be interested in one or more of the following: enhancing functional or life skills, developing academic skills needed for further education or to qualify for training programs, upgrading work-related skills, improving their ability to help their children with school work, and more. Some adult learners may lack experience with, or have low interest in, working collaboratively and communicating about mathematical problem-solving, having been "indoctrinated" by years of prior encounters with traditional drill-and-practice mathematics education in the K-12 system. Some adult learners have special learning needs.

The above factors pose a challenge to teachers who often need to accommodate within a single classroom a range of diverse students, and further do so under time constraints. The existence of these factors requires that teachers have adequate training, support, and resources in order to ensure that all students receive appropriate, quality instruction.

b. Teachers and teaching. While adult educators are dedicated to their educational mission, they are a varied lot. Some of the educators who are asked by their programs (or students) to teach mathematics (quite often in addition to teaching language arts, science, or other topics) have insufficient knowledge of mathematics, have received little training in mathematics teaching methods, or may have negative attitudes about applying or teaching math. Some teachers may also be unfamiliar with the nature of numeracy and literacy skills required in workplaces or with the specialized requirements of teaching in a workplace context; many have received little or no training on how to use educational technology (i.e. calculators, computers, videos) to support instruction of mathematics.

As training in modern mathematics teaching methods is lacking in most programs, the above realities can prompt many teachers, despite their best intentions, to rely on familiar, "traditional" methods of teaching math, causing an inadvertent contribution to skill gaps of students. The term "traditional" refers here to a type of instruction which: is based on the teachers' own school experiences with learning mathematics (which usually emphasized drill and practice), discounts the connection between school mathematics and everyday life, emphasizes individualized work in isolation from other students, ignores the students' informal "math sense" and prior knowledge, and does not link numeracy and literacy instruction.

In considering the nature of instruction, some participants commented that, over the years, some programs have developed drop-in learning centers employing an individualized, diagnostic-

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prescriptive method for placing and teaching students. This setup must be rethought to keep students from being isolated learners, and instead encourage cooperative learning which can be sustained over time.

c. Standardized assessment and instruction. Standardized tests such as the TABE or ABLE are widely used in the adult educational system, partly because of requirements of federal and state funding agencies. As test results and score gains may directly affect program funding, many teachers are pressured, explicitly or implicitly, to "teach to the test." In addition, the existence of such tests causes some students to want to invest efforts only in learning topics covered in a test. Such pressures often lead to narrowing of either the intended or implemented curriculum, by placing a premium on acquisition of computational skills, in contrast to other (math) subjects which teachers may find important but which are not addressed by a test. Under such circumstances, teachers sometimes have to cope with conflicting pressures from their program or students regarding their curriculum and instruction.

The extensive use of computational tasks and brief word problems in the mathematics sections of most standardized tests used in adult education programs provides both teachers and students with very limited information about students' numeracy skills. Results from such tests reveal little about students' mathematical intuitions, number sense, estimation, and flexible problem-solving and communicative skills. The frequent use of such tests also limits teachers' ability (and the students' own ability) to learn how well students can apply their classroom-based knowledge and skills to realistic everyday or work-related tasks (as opposed to their ability to solve, e.g., contrived word problems).

d. Mathematics curricula and learning materials. Textbooks, workbooks, and other instructional resources utilized by adult educational systems often reflect some of the worst traditions of K-12 mathematics education. This situation has prompted many teachers or programs to invest time and effort in developing or adapting materials for their local use in order to overcome what they see as major deficiencies of existing resources; such initiatives are obviously necessary from a local point of view, yet are duplicated across the system.

By emphasizing de-contextualized math, and by disregarding problem-solving and reasoning skills, existing materials do not foster the formation of skills and conceptual understanding which students can rely on when coping with real-life math-rich problems in workplace or everyday contexts. Few instructional materials for adults implement the open-ended, extended or cooperative problem solving activities that are increasingly emphasized in today's innovative K-12 classrooms. In addition, existing curricula do not encourage use of technologies such as computers and calculators in class. At present, calculators are not allowed when taking the GED and most other standardized tests. Although calculators are not excluded from use during instruction or during preparation for test-taking, both educators and learners do not have a strong incentive for using them.

e. Staff development. Training activities for teachers are almost nonexistent in the area of teaching mathematics to adults. Many teachers feel they lack support and have few opportunities to develop their teaching skills and become familiar with instructional innovations. The most common explanation given for this situation was that funding in adult education is insufficient and that little of it, if any, is allocated to math instruction issues.

2. Broader aspects of the current system which affect numeracy education

The status of mathematics education for adults, the preparedness of adult educators involved in numeracy instruction and staff development activities in this regard, and other factors discussed in the previous section have to be considered in the context of *general* characteristics of the adult education system which also affect adult numeracy education.

a. Funding. Over and again, participants bemoaned the fact that the adult education system is underfunded. The inadequacy of financial resources negatively affects adult education programs in four major ways:

- Limiting achievement of goals, by causing programs to be understaffed or underequipped, and by creating time and financial restraints;
- Limiting preparedness of teachers (and tutors), by restricting availability of and access to pre-service, in-service, and professionalization opportunities;
- Inhibiting development of instructional materials and not allowing for adequate experimentation with new methods or resources; and
- Limiting research initiatives (either academia-based or program-based); research is essential to provide insights into teaching and learning processes of adult students, and to better understand the factors affecting the application of what they have learned in real-life contexts or otherwise act in more numerate ways.

Overall, funding may prove to be a formidable barrier to future reform in adult numeracy education, in terms of its unavailability, as well as the pressure that it exerts on programs and teachers.

b. Accountability demands. Many participants pointed out that "hard" data (e.g., standardized test scores) collected about student achievement in accordance with requirements of funders, in large part do not reflect the range of accomplishments of adult education programs, adult educators, and adult learners. In effect, such assessments provide data on whether or not students met certain goals (e.g., test-score gain) which may not be compatible or reflect students' own goals. Some participants indicated that accountability measures presently do not focus on either the short-term or long-term goals of both the students and the program.

Further, funders might not be aware of or accept new frameworks for instruction (such as those based on NCTM and SCANS suggestions) or for assessment of mathematical knowledge (e.g., use of alternative or performance assessments or of holistic scoring). Definitions of achievement do not extend beyond passing a test to demonstrations of literacy and numeracy applications in broader social contexts, such as in vocational training, job performance, or everyday functioning. Thus, while new frameworks for instruction give teachers and students a broader and more complex agenda for action, programs' and students' work towards this agenda is only partially encompassed by current accountability measures.

c. Communication. Ineffective dissemination is just one of the myriad symptoms of poor communication in the adult education system. Although State Literacy Resource Centers and other agencies have been established to act as clearinghouses, materials from the national level filter very slowly to teachers at the local level; teachers remain largely unaware of standards, new teaching materials, technologies, and curricula in use outside their programs. Further, improvements in adult (numeracy) education are hindered when adult educators do not have opportunities to network, exchange ideas, and collaborate.

IV. Needed changes and possible "next steps"

Work process. On the afternoon of the second day participants rotated groups and continued to explore visions for a "better" system to improve mathematical literacy of adults, and examined factors or processes which may facilitate or hinder change. Each table was assigned one of the following questions:

1. ***Resources and support.*** **What new materials and resources would be needed to support the improvement of adult mathematical literacy? Who should be involved in this development process? Can materials be "borrowed" from K-12?**

2. ***Policy, funding, and provision system.*** **What changes may be needed in policy, legislation, or funding in order to improve adult mathematical literacy? What linkages or collaborations should be established between governmental agencies and organizations involved in adult education or mathematics education?**

3. ***Instruction and staff training.*** **What changes in instructional practices and in staff development processes would be needed in order to improve adult mathematical literacy skills? Who should be involved in attempts to change instructional practices and staff development efforts? What can be learned from the NCTM experiences with implementation of reform in the K-12 system?**

Based on discussions of the above and earlier questions, on Day 3 seven separate topical groups were formed (see below) and participants chose which group to join depending on their background and interest. Discussions on Day 3 aimed to develop specific suggestions for pragmatic "next-steps" or for needed changes, building on the shared knowledge and general ideas generated on earlier days when groups first responded to pre-assigned questions. Each group later presented a summary of its discussions to the whole assembly.

1. Creating an Adult Numeracy Practitioner Network

The creation of a national organization of adult educators involved in math/numeracy instruction was seen as essential by many of the participants. The need for this organization stems from the fact that K-12 mathematics organizations do not presently attend to adult mathematics education in non-college contexts, and literacy organizations usually pay little or no attention to mathematical issues. Participants who contributed to discussions on the network arrived at the following:

Mission. The practitioners who discussed the mission of a practitioner network proposed the following mission statement: "We are a community dedicated to quality mathematics instruction at the adult level. We support each other, encourage collaboration and leadership, and we influence policy and practice in adult math instruction."

Prototype Structure. The Network will initially operate as an independent organization that may become affiliated with a national organization in the future. An interim Steering Committee was selected, comprised of a coordinator (Mary Jane Schmitt, MA), and eight regional representatives who will be responsible for disseminating and collecting information from programs and states in their region. Ellen McDevitt (PA) volunteered to serve as editor of the Network's newsletter.

***Areas of activity for the Network*:.** Participants in this group offered four general goals for the Network as well as examples of activities to meet those goals on the local, state, and national levels:

Goal 1: To create awareness of the need for mathematical literacy. The Numeracy Network and all its members should work to raise awareness, promote mathematical literacy, increase political support via press releases, media coverage and advocacy activities, and promote math workshops at adult education conferences at all levels.

Goal 2: To participate in and effect staff development. The Network must encourage adult educators to utilize already existing structures for staff development in numeracy, such as State Literacy Resource Centers or local pre- and in-service training. At the same time, collaboration between adult educators and K-12 mathematics teachers can contribute to professional development in both communities. The Network should help adult educators to link with K-12-oriented staff development programs funded by NSF and by the Department of Education, as well as with local school district in-service offerings. The Network should also strive to increase attention to adult numeracy issues in conferences organized by state affiliated math teacher associations or by the National Council of Teachers of Mathematics. Conversely, ABE in-service activities could be open to K-12 teachers.

Goal 3: To identify funding sources. The Network should seek funding for math/numeracy education and training from federal and state agencies and from foundations involved in adult education; the Network should also help its members identify funding sources which traditionally have invested only in K-12 or college-level mathematics education (e.g., Eisenhower grants and National Science Foundation), which must be encouraged to open up to adult basic education.

Goal 4: To participate in research. Research initiatives should include teachers as active participants. Research projects should inform effective programming, teaching and assessments at both the local and national levels.

[Editorial Note: At this point in time (September 1994), six months after the conference, the Adult Numeracy Practitioner Network has published its first newsletter, titled The Math Practitioner. The network is investigating the use of an electronic bulletin board, holds regular communications between the regional representatives, and is planning a pre-conference meeting at the NCTM annual meeting in Boston in April 1995. Plans are underway to establish a more formal structure.]

2. Rethinking curricular goals and content

Many participants felt the need to establish a critical list of core skills essential for developing/ achieving "mathematical literacy," yet believed that this should be done in the context of a well-defined conceptualization of the goals of adult *literacy* education. The establishment of clear curricular goals ("standards") that should be emphasized in adult numeracy education seemed to participants in the content group as a critical step for "improving the system." The development of such standards should have an obvious impact on the focus of instructional activities and on the nature of materials used, and should serve as the basis for development of resources, planning the content of staff development activities, and designing assessment methods.

The "content group" suggested that critical skills would include:

- Number sense and operation sense;
- Understanding, organizing, applying and interpreting data;
- Measurement and spatial sense;
- Informal algebra.

This critical list of core skills must be open to change and comment, and should be viewed as a basic framework on which adult educators can expand. Participants in the content group suggested that a possible next step in developing curricular standards for adult numeracy education would involve examination of both NCTM and SCANS recommendations. Specifically,

- Adapt and implement the NCTM Curriculum Standards for adult mathematics education, perhaps using work of the Massachusetts ABE Math Standards Project, which modified the NCTM Standards for adult education contexts, as a point of departure. The first four NCTM standards (Reasoning, Communication, Connection, and Problem-Solving), were considered to be a "step in the right direction" rather than ideal standards for adult contexts.

- Examine what aspects of the SCANS reports may be relevant for adult education. SCANS described skills needed in high-performance workplaces and the educational implications for curriculum and for teaching (see chapters by Mikulecky and by Kloosterman in the Proceedings). Participants in this group felt that the SCANS curricular framework for a "generic" workplace instruction may have to be adapted for specific jobs due to the diverse nature of most jobs. (The "Work Transition Act," a recently-passed legislative act which fosters collaboration between local schools and businesses to make curriculum relevant to youth apprenticeship experience, is one context where the relevance of SCANS recommendations for different job clusters can be examined).

Curricular standards serve as a nucleus around which various elements of the "system" can be aligned. For example, several representatives of publishers, and others involved in materials and software development, stated that they would align their activities after standards are developed. As long as there are no such standards, they said, development efforts and planning of new resources lack coherence, as there is no systematic framework to guide them.

A revised framework of curricular goals should inform not only instruction, but also program evaluation. Formal "Indicators of Program Quality," which are now being devised by many states in accordance with federal accountability requirements, should explicitly address how programs handle numeracy instruction and specify how to assess students' progress in math/numeracy. However, any Indicator developed in the area of numeracy should be based on a *revised* statement of curricular standards as described above, rather than on outdated perspectives embodied in the present crop of standardized tests or mathematics textbooks for adult learners of mathematics.

3. Changing instructional practices and teaching resources

Participants in this group asserted that adult educators must reconsider the nature of their teaching practices and the learning environment they create for students who learn math/numeracy. General aspects of math/numeracy instruction which should be changed include:

- Consider students' educational backgrounds (including any special learning needs, e.g., in reading) in order to maximize mathematics learning gains;
- Use materials and textbooks geared for adult learners who have diverse sociocultural and linguistic heritages;
- Incorporate life skill activities (e.g., shopping, filing forms, paying taxes, cooking, crafts), realistic word problems, simulations, and business/career developmental skills, not only to develop conceptual understanding, but also to cultivate learners' sense that mathematics is connected to their real lives and can affect their future endeavors;
- Facilitate the development of communication skills, e.g., via classroom discussions, open-ended questions, and writing tasks about math/numeracy issues.
- Introduce workplace literacy components in the classroom to strengthen the connection between classroom instruction and the SCANS perspective on workplace skills;
- Utilize instructional tools such as manipulatives, calculators, computers, or videos;
- Begin to move toward cooperative learning in classrooms; and
- Assess students' demonstrated ability to apply math in diverse and realistic situations.

Specific practices that should be *de-emphasized* in numeracy instruction:

- Drill and practice, and over-emphasis on mathematics as computation;
- Exclusive reliance on paper-and-pencil tasks;
- Teaching specific content areas in isolation;
- Independent, isolated seatwork;
- Alienating environment that produces fear of math in the learner;
- Viewing the teacher as a lecturer and as the sole owner of knowledge (aka "sage on stage").

Specific practices that should be *accentuated* in numeracy instruction:

- Activity-based, hands-on materials;
- Collaborative/cooperative work in pairs or small groups;
- Mental math and estimating;
- Problem-solving, reasoning and communicative activities, as described in the NCTM Standards;
- Integration of content areas within math;
- Connections with other disciplines (e.g., science, social studies);
- Observations of uses and relevance of mathematics in everyday life;
- Development of a sense of a community of learners who are involved and have ownership of their learning of mathematics;
- Viewing the teacher's role as a facilitator (aka "guide on the side").

A wide range of individuals should be involved in teams developing learning materials and mathematics curricula expected to support changes in adult mathematics education. Development teams should seek input from adult students, teachers, program staff, and staff/curriculum developers in adult education programs, as well as be informed about recent research findings. However, development efforts should also take into account information about the needs of specific "customers" (e.g., business and industry, social service or community agencies, local community), and should examine and benefit from development efforts by K-12 mathematics educators.

The instruction group also identified four long-term suggestions which are essential to the proposed changes in instructional practices, and which relate to suggestions made by other groups: (a) change definitions and perceptions of math, (b) improve teacher comfort level and confidence in teaching math, (c) foster publisher acceptance of recommended changes, and (d) improve dissemination and communication networks.

4. Increasing adult students' involvement

This group asserted that adult students need to be increasingly involved in educational and administrative decisions which affect them. Reform efforts in numeracy education can best be accomplished by working *with* adult students, rather than by approaching reform as something that is done *to* students.

Three types of goals (in addition to program or teacher goals) exist regarding numeracy/math education; these goals may complement but also may contradict each other:

- *Student goals:* student goals are extremely important; if these goals are "out of sync" with other goals or are not met (from the students' point of view), then students will not come/stay in adult education programs.
- *Workplace goals:* often, there is a tension between student goals and company/workplace goals. Although this is not necessarily negative, educators must consider both sets of goals, and seek to align them if possible.
- *Community goals:* the community's perspectives about the goals of adult education must be included in student involvement initiatives and in program planning; these goals may differ, e.g., in urban and rural areas, or in areas with different types and levels of (un)employment.

Students and their communities must have the opportunity to express their concerns, their needs, and their goals to the adult education system. Collaborative efforts will enable adult education programs to be more responsive and effective in meeting the goals and needs of all stakeholders in the community. Six community stakeholders which can promote adult student involvement were identified by this group: (a) health clinics (b) schools and childcare centers (c) parents associations (d) local and state government (e) landlords and (f) churches and community action groups. These stakeholders, as well as local employers, could be responsible for utilizing active, team-building approaches to identify resources; direct correspondence; collect, provide and interpret needed data; and otherwise work with students and programs.

Greater student involvement can be implemented through processes such as:

- Discussions about curriculum and instructional methods and their relevance for students' life issues or future academic needs;
- On-going dialogues with teachers and other program staff concerning student and program goals (and their compatibility), and about expectations, responsibilities, and activities of students and teachers in the classroom;
- Decisions about assessment of student progress, and conversations about the use of assessment data in reports used for program evaluation.

5. Improving staff/professional development

This group focused both on issues of professionalism and of staff development. Participants felt that professionalism is not emphasized in the current system, even though it is fundamental for change in the adult education system. Professionalism positively affects adult educators' overall performance as well as the quality of students' education. It is difficult to see how adult numeracy education can regain a professional status when it gets little recognition from adult education programs, and when so many instructors work part-time and have little training.

Staff development should be on-going, consistent, coordinated, and in many cases, required. Participants in this group (as well as in the other groups which touched on staff training issues) argued that there is no comprehensive plan for improving staff development in math/numeracy at either the program, state, or national levels. Participants also pointed out that there are no mechanisms for certification of teachers in adult math/numeracy instruction, and that changing this situation will require significant increases in funding.

This group identified two areas where increased activity is needed to support improvement in effectiveness of staff development efforts: (a) collecting, generating and disseminating information about established staff development materials and about practical and successful staff development programs; and (b) increasing research on factors which influence the effectiveness of staff development programs, as well as more comparative research on the effectiveness of different models for staff development. (Several factors which were viewed as negatively affecting staff development [i.e. funding, part-time instructors, teachers' anxiety about teaching math] were discussed earlier and will not be revisited here).

The overall long-range vision as well as short-term goals for improving staff development focused upon the theme of *connectedness*. The group endeavored to improve the connections between the K-12 and adult mathematics education communities, and among different stakeholders in adult education. Specific suggestions for immediate action included:

- *Networking:* form and sustain a national coalition of educators interested in staff development in numeracy. Establish connections via state-designated staff development centers. Establish an electronic forum for exchange of information and suggestions among educators;
- *Dissemination:* increase dissemination efforts by newsletters, workshops, videos, and conferences. Identify a central clearinghouse which will coordinate dissemination in this area;
- *Coordination:* develop local, regional, and national goals for staff development in math/numeracy, which will be coordinated with other staff development initiatives in adult education. (A majority of adult educators also teach other topics besides math; also, some educators teach in workplace contexts, which require familiarity with additional techniques and teaching principles, beyond those available to teachers in non-workplace programs);
- *K-12 connections:* at the local and regional levels, facilitate collaboration and exchange of materials and ideas between adult numeracy educators and K-12 mathematics teachers; encourage and enable adult educators to participate in K-12 staff development activities, and vice versa.

6. Changing assessment frameworks

It is critical to align assessment with instructional goals and update assessment practices in light of the reform in classroom teaching and learning processes. Rather than relying exclusively on standardized, forced-choice instruments, assessment measures should also include portfolios, student self-assessment, and new tests which would involve performance-based and work-related problems.

This group discussed key issues in assessment and established several statements which reflected their viewpoints. Assessment should:

- Identify and set specific competency goals with learners;
- Inform the learner and guide instruction;
- Be ongoing and integral to instruction;
- Be process-oriented, and encompass math-related reading, writing, and communication skills;
- Reflect real-life tasks, situations, contexts, and needs;
- Reveal conceptual understanding and problem-solving skills;
- Include calculator usage;
- Employ multiple item types, question formats and context-based tasks to encompass a diverse set of skills;
- Provide information for multiple uses, including program evaluation.

The group emphasized that on-going assessment and exit evidence of competence for adult learners should rely on multiple sources of information, and thus that portfolios be used throughout a student's stay in a program. The group recommended that research on the development and proper implementation of new assessment measures be conducted, and that the group's work in this area continues.

7. Research support

Research should help identify critical aspects of adult learning processes, and contribute to our understanding of the factors which contribute to the effectiveness of specific mathematics curricula, instructional methods, materials, or state-of-the-art adult education programs.

The following areas were identified for possible future research:

- Definitions and nature of needed skills;
- Effective instructional methods;
- What makes certain staff development processes more useful;
- Effects of learner-centered instruction;
- Contribution of family math/literacy programs to students' knowledge and attitudes;
- How numeracy can be included in definitions of Indicators of Program Quality;
- How diversity in gender, ethnicity, and linguistic background can be used to support learning of numeracy skills;
- Learner perceptions of mathematics learning and their impact on learning;
- Resolution of the (philosophical) debate of the advantages/disadvantages and resulting impact of practical, "real life," or "functional math" instruction versus theoretical, academic, or "classroom" math.

Participants in this group had diverse research interests, and felt that few opportunities exist to share research results, to discuss issues of common interest in this area, or to collaborate on identification of a research agenda in adult numeracy education.

[*Editorial note: In addition to the work of this group, several other groups mentioned specific research questions in the context of discussing other topics; some groups stressed the importance of basing decisions about instruction, curriculum development and methods for staff training on the availability of better and more comprehensive knowledge which can be generated through both "academic" and practitioner-based research.*]

Taking a critical look back

By the end of the last day of intensive work, conference participants were quite energized to continue what had begun here. The conference committee, in their concluding remarks, reminded the group that while so much had been accomplished, it was impossible to have touched upon all issues adequately. So, participants were asked to write a "minute paper" to flag issues that were not discussed adequately and which should be addressed in the future, as well as to describe "surprises" (for good or bad) encountered at the conference. A sampling of responses follows:

What key issues were not discussed?

1. Regarding content, I would list "the politics of mathematical knowledge," i.e., understanding how political choices underlie supposedly neutral mathematical descriptions of the world, and that numerical data can challenge "taken for granted" assumptions about how the world or society are structured.
2. How does the "critical content" list meet the goals of students who have a high school diploma or GED, but need a "review" of math concepts for entrance into a college or technical school, given that colleges still emphasize lecture, drill and practice, and everything we want decreased?
3. How to avoid stopping information flow at the program manager's desk.
4. The use of technology other than calculators, e.g., computers/software, video and other instructional technology, Internet and teleconferencing [for numeracy education].
5. I am concerned that interdisciplinary learning may be slighted if we pursue math strictly.
6. Current national activities that will "feed" development of "standards" for adult education, such as at the Department of Education.
7. Addressed but hardly comprehended is preparation of students for taking math exams.

I was surprised that...

1. That some people did not know what the NCTM standards are...and that some people felt the NCTM Standards were incompatible with our work in adult literacy.
2. I was overwhelmed by the scope of the topic "mathematical literacy."
3. I was impressed with the level of the discourse, the commitment of the attendees, and the cohesion of the views expressed. I was dismayed at the realization of the struggle it must be for adult educators to accomplish their goals in terms of getting the information they feel they need and dealing with problems of retention of learners long enough to make a difference.
4. It was eye opening to discover that so many practitioners from all over the country have some of the same concerns about the delivery of the "math component" of adult education programs. Also, to discover how many different issues about staff development, materials, state and local level concerns, etc. that are out there.
5. I am concerned that we (practitioners) have such a difficult time coming up with a plan of action to continue the impact of this conference...If we cannot continue to be active, the conference benefits are greatly reduced. The newsletter seems like a good start, but we also need specific goals for all the participants (not just a steering committee).

V. Summary

1. Reflection on conference goals

To be sure, the Conference on Adult Mathematical Literacy had ambitious goals. While the participants were able to accomplish a great deal toward meeting those goals, some areas were inadequately addressed due to time constraints. With respect to each of the four conference goals, the following is a brief analysis of what was accomplished and what was left unaddressed:

Goal 1. To identify issues contributing to the lack of mathematical literacy skills in the adult population, and to assess the capability of the current adult education system to handle the challenge of improving numeracy skills.

By the end of the conference, a clear picture emerged of the under-resourced adult education system and its generally spotty attempts to provide quality mathematics education to adults in need of improving their numeracy skills. Yet not much time was spent discussing the factors that contribute to "innumeracy" in the adult population, including the effects of K-12 and adult education as well as societal factors. Adult education leaders at the state and local levels, who were only sparingly represented at the conference, must also be involved in the dialogue on adult numeracy education, to provide a more comprehensive picture of future policies and funding, and about decision-makers' visions for the place of numeracy provision in this context.

Goal 2. To examine reform movements in mathematics education that can serve as a basis for changing adult numeracy education.

The reform movements and curricular frameworks offered by NCTM, SCANS, and the Massachusetts ABE Math Standards Project, were well-covered and provided inspiration for future endeavors. Some of the potential advantages of establishing curricular standards in math/numeracy were also explored. Yet, we have not had time to connect with the broader debate among adult educators about the role of standards in adult education programs. Specifically, given that numeracy education often takes place within literacy or basic skills classrooms, we have barely begun to examine how curricular standards in numeracy may be aligned or integrated with emerging curricular standards in other areas of adult literacy education.

The reform movement in K-12 mathematics education has begun to examine not only curricular goals, but also teaching practices and the nature of the instructional environment created in classroom contexts. In the conference we started to examine needed changes in teaching. However, we need to further examine what aspects of the K-12 (or college) mathematics teaching frameworks may be appropriate or can be adapted for adult education, given the unique features and contexts of adult learning.

An important element in K-12 mathematics education reform has been the growing recognition that a broader and richer set of assessment practices (e.g., portfolios, performance-based measures) needs to be in use to evaluate the range of skills, knowledge, and strategies that are involved in learning and applying mathematics in a variety of actual situations. A similar emphasis on changing assessment practices in *adult* education is needed. Specifically, the following issues need to be addressed: (a) aligning the scope, content, and format of assessment tools with the scope, content and methods of instruction; and (b) developing tools which can offer diagnostic information (for teacher and student use) as well as provide useful information for reporting to funders and for program evaluation. The need for integrated assessments has been recognized for some time, yet a bold initiative in this regard seems crucial to ensure the success of any reform efforts in adult mathematics education.

Goal 3. To initiate plans for action at the national, state and local levels, which would incorporate perspectives of members of the mathematics education and adult education communities, and of all other stakeholders involved in adult education.

The conference brought together, for the first time, adult educators and mathematics educators from different communities. At the meeting, adult educators became acquainted with the work of NCTM and SCANS; mathematics educators learned about the diverse population of adults who seek quality mathematics education and about the complex system that provides the education and training for adult learners. There were numerous suggestions for action at local, state, and national levels to strengthen mathematical education; these recommendations could provide a basis for a coordinated plan of action. However, before a formal plan is finalized, it is essential that more stakeholders provide input.

State directors of adult education, State Literacy Resource Centers, employers, and adult students need to be heard. More information is needed about the federal government's plans for adult education (e.g., how numeracy issues will be handled in the upcoming system of Indicators for Program Quality), and about upcoming or recent legislation (e.g., the reauthorization of the Adult Education Act and any attention it gives to numeracy issues, or how basic skills instruction and mathematics education are handled as part of School-To-Work initiatives taken after the passage of the Work Transition Act).

Goal 4. To create a grassroots network of practitioners interested in reforming mathematics instruction in adult literacy education.

An Adult Numeracy Practitioners Network was established at the conference. A committee of eight regional representatives was selected to continue the creation of the Network. A newsletter editor began to collect data at the conference. (The first issue of the newsletter, "The Math Practitioner" was released in late July.) Important ideas about the goals, scope, and possible activities of the network have been discussed. To enable the fledgling Network to grow into a solid and influential organization, questions regarding the formal structure, funding sources, and long-range working plan of the Network need to be discussed and decided. The Network Committee is planning to arrange a meeting of Network members in April 1995 in Boston, at the NCTM Annual Conference to further address such questions.

2. Where do we (and you) go from here?

Dissemination. The culminating goal of this report on the Conference discussions is to inform a discourse on improving adult numeracy education and to help initiate a reform movement in this field. Toward that end, this report is being widely circulated to conference participants, endorsing organizations, state and federal agencies involved in adult literacy or mathematics education, and other stakeholders. We encourage you to join us in bringing this report to the attention of all stakeholders with which you can connect.

Initiating action to inform policy and practice. In the few months since the conference, we have heard from numerous participants about activities they have undertaken locally to increase awareness and urge their colleagues to action, with the confidence that their actions are based on solid discussions at the conference and are echoed elsewhere. Some have arranged meetings with state or regional directors of literacy education in order to present pointed questions and suggest courses of action; some have made presentations in local conferences or have written an article for their local newsletter; some took steps to connect with local K-12 educators, and others have formed a "study circle" or "inquiry group" of adult educators who are interested in examining their math teaching practices. It appears that there are many ways to "make a difference." We hope that such actions will continue and grow around the country.

Networking. While we are very optimistic about the future of the fledgling Adult Numeracy Practitioner Network, it is unclear at present what direction it will take and how successful it will ultimately be in affecting the state of numeracy education for adults. What is clear is that grassroots action is essential to ensure that programs and teachers continuously examine the nature of numeracy education and strive to improve their services. We urge you to consider joining the Network or contacting its regional representatives (see Appendix D).

In conclusion, the conference co-chairs and editors of this report express thanks to the many organizations and individuals who contributed to the important work of ensuring mathematical literacy for all.

Chapter 1
Proceedings of the 1994 Adult Mathematical Literacy Conference

REFLECTING ABOUT THE GOALS OF ADULT NUMERACY EDUCATION

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--- *If you don't know where you are going, you can't know if you have arrived there.*

Purpose

This paper examines the issues and tensions involved in defining the goals of adult numeracy education. The relative and dynamic nature of numeracy skills, the existence of multiple perspectives on numeracy, and the links between literacy and numeracy are discussed and their instructional implications outlined.

Introduction

In the United States, the 1991 National Literacy Act's definition of literacy recognized the need to attend to adults' quantitative skills:

> *[Literacy is] an individual's ability to read, write and speak in English, and to compute and solve problems at levels of proficiency necessary to function on the job and in society, to achieve one's goals, and develop one's knowledge and potential.*

This definition leaves latitude for a wide variety of interpretations by curriculum designers, program directors, funders, and educators regarding what might be included in the terms *computational skills* and *problem-solving skills.* Given such circumstances, the adult education and math education communities in the United States, including learners, practitioners, policymakers, administrators, and researchers, would be expected to have opened a dialogue to clarify the goals, methods, and mechanisms for enhancing adults' quantitative skills. Despite the acknowledged centrality and importance of numerical skills and quantitative information in both everyday and workplace functioning of adults, there have been few, if any, signs of public discourse on numeracy-related issues within the adult education and mathematics education communities.

A central question involves the nature and scope of the quantitative skills that adults should possess (i.e., the definition of what "numeracy" or "mathematical literacy" may encompass). The answers to this question are critical since they will serve as the basis for determining the goals of instruction, and for designing curricula, teacher-training efforts, and assessments in adult numeracy education. This paper outlines several observations and raises questions that need to be considered while discussing the goals of numeracy education.

A single ladder or multiple ladders?

In light of the multiplicity of views about the nature of literacy (e.g., Venezky, Wagner, & Ciliberti, 1990) and the definition of literacy in relative terms found in the 1991 National Literacy Act, it is essential to view numeracy as both relative and dynamic, rather than discuss it in absolute terms and assume that "being numerate" has a fixed meaning.

The nature and level of the skills that any individual may need to possess usually depend on the characteristics of particular environments (e.g., workplace, home) where this individual may have to function. Needed skills may change over time, depending on personal life circumstances, job transitions, and changing realities or technological shifts in everyday and work contexts. For example, processes of both "skilling" and "de-skilling" can be observed in jobs and daily tasks (Bailey, 1991). It is not yet clear that higher mathematical sophistication will be required as the world becomes more technologically advanced. A change in the type(s) of needed skills, rather than just an increase in skill demands, may lie ahead. (Consider, for example, the nature of the change in the computational skills that people may need to possess as inexpensive calculators become more prevalent, or the effect of the availability of barcode scanners on the skills required of cash-register operators).

In contrast to the above dynamic and relative view of numeracy, consider that among K-12 mathematics educators in the United States there seems to be some agreement upon a single ladder of mathematical skills that *all learners* are expected to climb—after learning the four basic operations, students routinely move to proportional topics (fractions, decimals, and percents), then to algebra, geometry, and finally calculus. Some measurement and graphing or data-analysis skills may be introduced at different points. Buying into this system assumes that all learners of mathematics (and thus all adults) should possess the same set of skills, and that to achieve these skills all learners have to climb a single ladder, that is, follow the same linear steps throughout their schooling.

The ladder metaphor has driven the design of many textbooks and assessment tools. Children learning math in school are expected by teachers to reach the top of the ladder. Students who cannot cope with what many high school teachers view as "real" mathematics (i.e., mastery of abstract mathematics and of algebra and calculus) are usually banished to the likes of a general mathematics course (Steen, 1992), which many mathematics educators consider a dead end.

To what extent is the ladder metaphor at all relevant or helpful to an educator who has to plan instruction for adult students seeking to improve their functional skills? Consider that there are multiple and often interrelated purposes for which adults seek to develop their numerical skills, such as:

- everyday functional demands (e.g., shopping);
- workplace demands;
- recreational/social uses (e.g., crafts, church);
- issues/processes of public interest (e.g., understanding results from a poll discussed on TV, or figures about crime in the neighborhood);
- participation in public discourse;
- further education (e.g., college-level courses; pass the GED); and
- help one's children with their (math) homework.

Do all of these contexts require the same set of mathematical skills? Some foundational skills, like counting, a sense for magnitude of numbers, or some understanding of ideas of addition and subtraction (and perhaps ratio) may be needed in most of the above contexts. Other mathematical skills and skill with handling numbers embedded in text (which requires certain literacy skills) may be needed in some but not other contexts. Thus, the single ladder metaphor must be replaced with a multiple ladder notion. How high on each mathematical ladder does one need to climb in order to be an effective citizen, worker, shopper, or parent is a question for further research and reflection.

Can students apply learned skills outside the classroom?

While K-12 math instruction usually develops specific mathematical skills in simulated environments (e.g., through word problems), adult education also has to enable learners to take action or "make sense of the world" *outside* the classroom, in part by providing *functional* skills. The traditional emphasis on "academic" mathematical skills assumes that learners are able to transfer their skills from the classroom to other contexts. This assumption often may not hold true in reality; as math teachers discover all too often, learners have trouble handling problems not resembling those used in class. What are the implications of the demand for transferability on instructional practices? Are teachers prepared to teach for transferability? How should an instructor go about assessing the transferability of learners' skills (if the learners' purposes for learning require transfer of skills)?

In reflecting on factors that affect adults' ability to acquire and in turn apply mathematical skills, it is important to consider that negative attitudes, "math anxiety," and unhelpful beliefs, are routinely seen in adult learners. (Learners usually attribute such dispositional states to negative experiences that they had as students in K-12 schools). This is of importance, since the degree to which a numeracy-related situation or task is well-managed depends not only on technical know-how (i.e., knowledge of mathematical rules, operations, and principles), but also on the actor's dispositions, beliefs, habits, self-concept, and feelings about the situation (McLeod, 1992), as well as on the actor's metacognitive skills. Frequently, adults—including those who are highly educated—feel that they are "not good with numbers" and elect to avoid solving a problem with quantitative elements, address only a portion of it, or seek help from someone (e.g., a family member or a salesperson). Thus, it appears that one basic goal of adult numeracy education is to develop students' positive attitudes in their own mathematical power and positive beliefs about the contribution of mathematical reasoning to their real-world functioning.

Who should define what adult numeracy may encompass?

For some years, three different communities—employers, mathematics educators, and designers of assessment tools—have been presenting, explicitly or implicitly, ideas that frame in overlapping but different ways the nature of the quantitative skills adults may need to possess. A comprehensive framework for what numeracy development may encompass needs to integrate these various perspectives.

Employers. Several initiatives have been taken in recent years to identify the basic skills that employers expect of their workers and to define the role of trainers and educators in this regard. Well known efforts include a project by the American Society for Training and Development (Carnevale, Gainer & Meltzer, 1990) and work by the Secretary of Labor's Commission on Achieving the Necessary Skills (SCANS, 1991, 1992). These and other studies view quantitative skills as one of several foundation skills, which include as well reading, writing, and related communication skills. SCANS (1992), for example, distinguishes between arithmetical and mathematical basic skills expected of a worker, as follows:

> *SCANS arithmetical skills: Perform basic computations; use basic numerical concepts such as whole numbers and percentages in practical situations; make reasonable estimates and arithmetic results without a calculator; and use tables, graphs, diagrams and charts to obtain or convey quantitative information.*
> *SCANS mathematical skills: Approach practical problems by choosing appropriately from a variety of mathematical techniques; use quantitative data to construct logical explanations for real world situations; express mathematical ideas and concepts orally and in writing; understand role of chance in the occurrence and prediction of events (p. 83)*

The quantitative skills desired by employers are broader than mere facility with the mechanics of basic number operations; they also include some knowledge of statistics and mental computation strategies, and emphasize general problem-solving ability. Employer definitions that introduce new demands for communication skills about quantitative issues or with quantitative information considerably expand what is considered under the heading of basic quantitative skills. Finally, employers emphasize the need to develop integrative skills that are applicable in such a way that workers can prioritize their actions and draw on a wide range of foundation skills in order to handle assigned tasks in a timely fashion.

Mathematics Educators. Although employers have focused mostly on practical numeracy skills and on communication about numerical issues, K-12 educators associated with the mathematical sciences have paid more attention to the importance of numeracy, or quantitative literacy, in civic, scientific, and social contexts. One influential report, *Everybody Counts: A*

Report to the Nation on the Future of Mathematics Education, (National Research Council, 1989) states:

> *To cope confidently with the demands of today's society, one must be able to grasp the implications of many mathematical concepts—for example, change, logic, and graphs—that permeate daily news and routine decisions....[F]unctional literacy in all of its manifestations—mathematical, scientific and cultural—provides a common fabric of communication indispensable for modern civilized society....[M]athematical literacy is especially crucial because mathematics is the language of science and technology. Discussions of important health and environmental issues (acid rain, waste management, greenhouse effect) is impossible without using the language of mathematics; solutions to these problems require a public consensus built on the social fabric of literacy.*

Curriculum and Evaluation Standards for School Mathematics, released by the National Council of Teachers of Mathematics in 1989, expand the scope and nature of what mathematics teaching and learning may entail well beyond traditional notions of drill-and-practice instruction. NCTM's *Standards* urges educators to create a problem-solving context for teaching mathematics, where students have to reason about mathematical concepts and processes, and then communicate about them. As definitions of adult literacy expand to include quantitative issues, the goals of K-12 mathematics appear to be expanding to include communicative elements.

Assessment Programs. Dimensions of numeracy are also reflected in frameworks, content, and item formats of tests and surveys of general literacy or basic skills. Most relevant for the purpose of the present discussion is an approach developed at the Educational Testing Service for large scale surveys of adult literacy skills, and used in the National Adult Literacy Survey (NALS; see Kirsch, Jungeblut, Jenkins, & Kolstad, 1993). This assessment framework distinguishes between three separate but interrelated facets of literacy: Prose literacy, Document literacy, and Quantitative literacy. Kirsch and his colleagues defined *quantitative literacy* as the knowledge and skills needed to apply arithmetic operations embedded in written materials; they assessed this type of literacy skill by using realistic functional tasks (e.g., filling out a bank deposit slip; reading a menu and computing the cost of a specified meal to determine the correct change from a given amount) while varying the arithmetic operations to be performed, the number of operations to be performed, and the degree to which the operations were embedded in text.

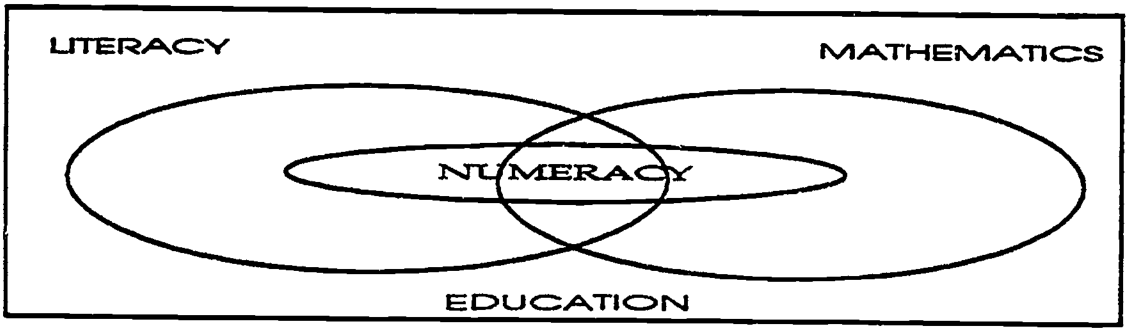
In addition to "quantitative literacy" tasks, which involve arithmetic operations on numbers embedded in print, some tasks classified as "document literacy" tasks require comprehension of textual materials with embedded numbers, but without requiring any manipulation of the numbers (e.g., reading a bus schedule). In all, the NALS approach highlights the strong links between numerical and linguistic skills in functional contexts, and the difficulty of defining what is numeracy without taking into account literacy issues, a perspective that was less evident in views of numeracy discussed earlier.

With the above said, it is important to note that the NALS definition of "quantitative literacy" focuses on tasks involving arithmetic operations only, as opposed to functional tasks involving skills from other mathematical domains, such as measurement or understanding of spatial relations. Further, it focuses primarily on the performance of operations that have only right or wrong solutions, even though many everyday or work-related tasks do not necessarily require a precise or "right" answer, but rather require people to plan and optimize the use of resources.

Literacy and Numeracy are interrelated but separate

Mathematics instruction as presently implemented in K-12 schools and in many adult education programs often does not focus on the skills actually called for in many functional tasks. While some real-world tasks may call for application of "pure" literacy (i.e., reading, writing, communication) skills or "pure" math skills, other tasks will call for application of integrated math and literacy skills. As depicted in figure 1 below, numeracy is a skill domain which involves a subset of essential skills from both mathematics and literacy. "Being numerate" involves possession of some literacy skills and some mathematical skills and being able to use them in combination, as required by the situation at hand.

Figure 1



It might be impossible to speak of developing full literacy—in terms of reading, writing, and communication skills—without also establishing an understanding of various quantitative concepts and the ability to communicate with or about them effectively. At the same time, language plays a critical role in both learning math (e.g., reading often incomprehensible math textbooks, solving word problems; see Pimm, 1987) and in handling real-world tasks involving mathematical elements (e.g., reading shipping instructions, making sense of a newspaper article with embedded statistics). The tradition of separating instruction in mathematics from instruction in other areas can easily impede the development of integrative and useful numeracy skills, in part because the functional situations in which numeracy skills are called for do not fit with instructional tasks traditionally used by to teach language arts and mathematics.

One particular example for an area where the linkage between literacy and numeracy has been *under*emphasized is that of *interpretive skills*. A major purpose of adult education (and K-12 education) is to enable all students to be effective citizens and participate in social and civic processes; this requires ability to comprehend and critically evaluate statements and arguments presented by politicians, administrators, or advertisers. Yet, mathematics educators have little experience in developing students' ability to comprehend textual or verbal materials with embedded mathematical elements, such as those frequently encountered in newspapers, on TV, or in workplace documents. Likewise, mathematics educators are unfamiliar with principles for assessing students' comprehension of textual materials with embedded numbers or figures.

Summary

The above discussion implies that numeracy, as a target for adult education efforts, refers to an aggregate of skills, knowledge, beliefs, and habits of mind, and general communicative and problem-solving skills, which individuals may need to possess to effectively handle real-world situations or interpretive tasks with embedded *mathematical* or *quantifiable* elements.

The goals of adult numeracy education overlap with, but also stand apart from, the traditional goals of both adult literacy education and adult mathematics education. Literacy and math instructors often do not emphasize numeracy skills, as they may appear to be functional, "messy," and distant from the "pure" reading, writing, or math skills on which instruction in these areas has traditionally focused. In the case of mathematics education, for example, many teachers have focused on imparting "academic" skills, even though such skills are not directly applicable to real-life situations confronting the majority of the adult population. The study of mathematical skills such as algebra or geometry may of course constitute a legitimate goal for adults seeking to pursue further formal studies of mathematics; yet, the study of such topics can be seen as falling outside the domain of numeracy, and can be justified only if instruction is done in a functional context and in connection with the broader goals of adult education.

In closing, key points which should be considered in discussing the goals of adult numeracy education include:

- Numeracy is not a single, fixed set of skills and dispositions which fit into a "single ladder".
- To enable adults to act in a "numerate way," literacy and numeracy skills must be jointly developed and integrated to enable effective functioning in various contexts.
- Numeracy emphasizes procedural, action-oriented skills, as well as interpretive skills. Learning environments need to emphasize transfer of skills, not only acquisition of component skills (i.e., specific algorithms or methods) in a classroom context.
- The multiplicity and specific nature of life contexts in which learners may need to use numeracy or more formal mathematical skills presents many challenges to adult educators, who must be able to provide a wide range of classroom experiences to address the cognitive, metacognitive and dispositional demands of these different contexts. Adequate training and sustained staff development activities are required to prepare adult educators for the challenges involved in developing numeracy skills of adult learners.

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Chapter 2

Needed Skills and Skills Gaps: Adult Numeracy Demands, Abilities, and Instruction

1994 Adult Mathematical Literacy Conference

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Purpose

This paper reviews numeracy demands in contemporary workplaces providing concrete examples of numeracy tasks faced by employed adults. A brief review of adult performance in the quantitative section of the recent National Adult Literacy Survey provides an overview of the degree to which adults in various occupations are likely to have difficulties with numeracy demands in current workplaces. The paper concludes with a discussion of guidelines from the US. Department of Labor's SCANS competencies with concrete examples of methods instructors can use, following SCANS guidelines, to address the gap between adult numeracy abilities and current workplace demands.

Numeracy Demands

The demands made on the numeracy skills of workers are increasing as growing numbers of employers require a flexible workforce capable of performing multiple information processing tasks including team decision-making about how to monitor and improve productivity. As part of teamwork, planning and quality control, workers need to be able to solve problems which often involve the application of numeracy skills. These may well include reading graphical computer output, calculating means and ranges, and making judgments about changing machine settings. Typically, in order to carry out a task involving numeracy, a worker will also need to read instructions written in prose or consult a document detailing procedures. Numeracy skills required in the workplace can be divided into four general areas: calculation, measurement, handling data, and problem-solving. This is an artificial separation, but it is a useful one for an educator when analyzing the requirements of a particular job or type of job.

Examples of workplace *calculations* include adding up the total price on a delivery form, finding a percentage discount on an insurance premium, subtracting two fractional lengths marked on a blueprint, and working out the proportions for mixing two chemicals. The method used will depend on the calculation and the context in which it is done. A worker will choose (or may be forced into by the circumstances) mental arithmetic, paper-and-pencil or calculator. Ideally, the worker will check the answer to see if it is reasonable using another, approximate, method. This means that the educator needs to teach the workers how to choose appropriate techniques and how to estimate sensibly, as well as the particular skills needed for the calculations that a job requires.

Measurement in the workplace can involve not only direct measuring with ruler or micrometer, but also setting dials on machines which then do the measuring. In either case, care and accuracy are required, as well as an appreciation of the permitted tolerances in a particular situation. Examples include measuring lengths of wood with a ruler to an accuracy of sixteenths of an inch, measuring diameters of wire with a micrometer to within thousandths of an inch, and setting a machine to weigh bags of sugar to an accuracy of tenths of an ounce.

Workplace *data* comes in many forms, and so do the methods for handling that data. Much of it is now computerized, and so workers need to be able to interpret what they see on a screen and use a keyboard to react to it. Other workplace data appears as printed graphs, charts or blueprints. For example, a customer service representative dealing with a client's query will have to key in an identity code to bring up on a screen the details of that client's case, and then read off the information relevant to the particular question, and possibly make calculations and changes to the computer entry as a result of that query—and do all this while talking to the client on the telephone. In another case, in manufacturing, a worker monitoring the production of a machine will receive a graphic print-out every hour and will need to interpret the information contained in the graph, in order to make changes to the machine's operation.

Problem-solving in the workplace will usually bring together some of the other areas mentioned above, but it has its own characteristics. Principally, problem-solving will entail making judgments: about the information which is needed to make a decision, about the relative weight to give different pieces of information, about the appropriate action to take. Often problem-solving will be a shared activity, requiring communication, teamwork, and analysis of information in various formats. This may make the decision-making less of a burden on one individual, but it involves other skills of cooperation such as explaining clearly, listening carefully and reaching consensus. Because problem-solving interacts so much with the other skill areas, it is difficult to give examples of it in isolation, so it will be considered further in the detailed examples of workplace tasks which follow.

Example 1 Statistical Process Control

Statistical Process Control is a way of monitoring the production of a machine while it is in operation, and making necessary adjustments in order to maintain a standard quality of production. At regular intervals, the machine operator takes samples of the product (which may be bottles of soda, lengths of planking or packages of macaroni and cheese) and *measures* the volume, length or weight of each unit in the sample. These *data* are then recorded on a form and the mean and the range of the sample values are *calculated*. The worker plots the mean and range on a *graph*, which already includes values from samples taken earlier in the day.

Then comes the *problem-solving*. The worker needs to decide whether production is still within pre-set tolerances and, if not, by how much to adjust the settings on the machine. Too small an adjustment will not solve the problem, whereas too great a change will turn under-weight into over-weight, producing a new problem. Keep in mind that the machine is still in production while all this is happening, and a worker's speed in dealing with the sample and taking the decision will avoid costly wastage of materials and production time.

Example 2 Customer Service

A customer service representative (CSR) handling billing inquiries receives a telephone request for late payment. After asking for the customer's name, the CSR can pull up the whole of that customer's *record* on a computer screen and check on the payment history. At this point, there is an initial *decision* to be made: How reliable is this customer? Can any extension of time be given?

If an extension seems to be in order, the CSR then consults a *set of rules* concerning the length of such an extension and whether some percentage of the bill must be paid immediately. After *calculating* the effect of the rules in this case, the CSR tells the customer the result—and probably generates a discussion on the possibility of the customer paying as required. Again, the CSR must make a *decision*, within the limits of certain discretionary powers, which will produce the solution most likely to lead to payment and a satisfied customer.

Example 3 Quality Assurance Teams

In high-performance workplaces, teams of workers representing activities at various stages of production often meet in what are called "quality assurance teams". The purposes of such teams are to identify problems, jointly set new productivity goals, and discuss the results of monitoring productivity at various stages of production (i.e., where are the mistakes or slow-downs happening and what can be done about it).

A typical team problem is too much inventory—skids loaded with parts or finished product—on the floor. A major productivity goal is "just in time" production, so that material is ready for the next stage of production or for the customer exactly when it is needed. This cuts down on spoilage, breakage, pilfering, and needed warehouse space.

To solve problems like this, 4 - 6 workers may spread inventory *graphs* on a table. Such line graphs record the amount of inventory in various locations at various points in time (by the hour, day, week or month). Synthesizing information from these graphs can allow the team to determine when build-ups of excess inventory (i.e., parts or finished product) are occurring. Team members will offer *problem-solving* suggestions on why the build-ups are occurring (e.g., the new person at Stage 4 is having a hard time keeping up, the second machine at Stage 3 has been requisitioned for a special order project, breakdowns are occurring on the first machine at Stage 3). Additional information is then gathered on suggested possibilities. For example, what would happen if a worker at Stage 3 went to help at Stage 4 every other hour? Alternative *computations* of output might involve working with half-day or two-hour splits of time. Speculations about machine breakdowns might involve checking when the machine was last overhauled and re calibrated, looking up projected times between maintenance, and computing the time before the next scheduled maintenance. Pulling up machine *records* of the questionable machine during a comparable time during the last maintenance cycle would provide information to justify a call for early maintenance. New and old work orders would be scanned to see how many parts are called for in the special order which took a machine off line. Based on performance so far, *computations* and *estimates* would be made for how long it would remain off line. The culmination of all this brainstorming and quantitative information-gathering would be a plan to increase production speed and reduce the amount of inventory on the floor. This would involve *deciding* which workers and machines would do what tasks, setting goals, *counting* and making *measurements* at regular intervals, and *recording data* to monitor the various stages of production. In 3 - 5 days time, the quality assurance team would meet again briefly to determine how well goals had been met and how well problems had been solved.

Worker skills demonstrated on the National Adult Literacy Survey

To give some idea of the gap between the need for skills in the workplace and the actual skills of workers, consider some of the results of the recent National Adult Literacy Survey (NALS) (National Center for Educational Statistics, 1993). The more than 26,000 adults who participated in the survey were given tasks of varying difficulty to accomplish using realistic scenarios and materials. The percentage of adults correctly completing various prose, document, and quantitative tasks was used to establish task difficulty ratings along a 0 - 500 scale. Then, each adult surveyed was given a proficiency score on the same scale according to the tasks successfully completed. For example, the task "Total a simple bank deposit entry" was rated at 191 on the quantitative scale, and adults with a proficiency score of 191 would be given that score because they had a high probability (80%) of completing that item. These adults would then have a steadily decreasing probability of success with more difficult tasks given higher ratings of 250, 300, 350, etc.

The full scale 0 - 500 is divided into five levels of task difficulty and respondent proficiency. To give some idea of the five levels, here are some example tasks from each level. These tasks illustrate not only the quantitative scale, which is directly related to numeracy, but also the prose and document scales. This is in order to emphasize the point that the use of such skills in the workplace will usually be integrated across the three areas.

Selected Tasks from the National Adult Literacy Survey

Level 1 (0 - 225)	Identify a country in a short article. Locate the time of meeting on a form. Total a simple bank deposit entry.
Level 2 (226 - 275)	Locate an intersection on a street map. Calculate postage and fees for certified mail. Calculate the total costs of a purchase from an order form.
Level 3 (276 - 325)	Write a brief letter explaining a billing error. Find information from a bar graph of energy sources. Calculate miles per gallon using information on a mileage record chart.
Level 4 (326 - 375)	Explain the difference between two types of employee benefits. Use a table to determine the pattern in oil exports across years. Determine correct change using information on a menu.
Level 5 (376 - 500)	Summarize two ways lawyers may challenge prospective jurors. Use information in a table to complete a graph, including labeling axes. Using a calculator, determine the total cost of carpet to cover a room.

The NALS results showed that 21% - 23% of adults nationally perform within Level 1, and 25% - 28% within Level 2. This, of course, includes those not in the workforce, but does indicate that about half the adult population performs at these lower two levels. A comparison of the tasks listed above with the skills now required in many workplaces, particularly those described in the three detailed examples of the last section, shows that many workers have a large skills problem and will find it difficult to carry out jobs which are becoming steadily more complex. This is true of both numeracy skills and others in the prose and document areas, which are used together in order for workers to perform their jobs satisfactorily.

Only the most basic jobs are limited to the simple use of addition and subtraction represented by Level 1 tasks. Some degree of form filling is called for in 70% of jobs and this often involves taking information from one source (e.g., a table, chart, or machine display) and performing some kind of calculation upon the information. Such relatively simple tasks parallel those of Level 2 on the NALS quantitative scale. Much more typical of changing workplaces, however, are the tasks represented at Levels 3, 4 and 5 which call for the use of calculators, problem-solving, setting up computations, gathering information from several sources, and estimating to check the reasonableness of answers. Researchers have consistently found the vast majority of workplace materials—manuals, memos, new product information, trouble-shooting directions—to be of high school or college level difficulty. (See, for example, Mikulecky and Diehl (1980), Sticht (1982), Mikulecky (1982), and Rush, Moe and Storlie (1986).) This is comparable to Level 3 of the NALS. In most occupations, therefore, workers whose quantitative competencies are only at Level 1 or 2 (i.e. 40-50%) are obvious candidates for some basic skills training. Even in workplaces which haven't moved toward SPC and Quality Assurance teams, more than a fifth of workers are likely to have difficulty with basic measurement and computation tasks. Adults in basic education programs who are not yet ready to pass the GED tend to score at the very lowest NALS level.

SCANS: A Recommended Instructional Approach

The US. Department of Labor instituted an advisory committee on skills necessary for functioning in today's workplace (Secretary's Commission on Achieving Necessary Skills) in 1990. The charge of this commission was to determine what skills educators should be teaching to prepare learners for the current and future workplace. The Commission reports that increased competencies are needed in the five areas listed and described below.

Resources - Identifies, organizes, plans, and allocates resources.

Interpersonal - Works with others on teams, teaches others, serves clients, exercises leadership, negotiates, and works with diversity.

Information - Acquires, organizes, interprets, evaluates, and communicates information.

Systems - Understands complex inter-relationships and can distinguish trends, predict impacts, as well as monitor and correct performance.

Technology - Works with a variety of technologies and can choose appropriate tool for task.

The Commission did not recommend that educators necessarily attempt to directly prepare learners for particular jobs. It did suggest, however, that learners become involved in many more long-term tasks and projects which call for increasingly complex applications of these competencies. For example, scheduling resources like time is something that the Commission says could be expected of learners regularly. This would begin with scheduling one's own time, move toward scheduling a team, then to a time line for project completion, and so on.

The Commission does not recommend that these competencies be taught separately. The should all be integrated as parts of long and short term projects which involve both *individual* and *group* effort. Recent research continues to underline the fact that separately taught skills do not transfer very well to real-world applications for most people. An example of a SCANS activity designed for a group of high school math students follows below. Similar activities could be developed for adults.

SCANS Activity

Activity Description: Using a set of building and landscape drawings from a local contractor have teams of 4-5 students determine amounts of specific materials and cost estimates for those materials. Each team would be responsible for contacting a different building supplies dealer for determining cost of materials. The result will be a written materials list and cost estimates prepared for the contractor and/or home buyer. Cost comparisons from different building supply dealers would be a useful outcome of this project.

Resources: Teams would need to decide the following:

- Identify different areas and materials used in proposed building and landscape
- Allocating responsibilities
- Determine tools needed
- Time to estimate, analyze and write up results

Interpersonal:

- Letter writing to contractors to gain cooperation for project
- Teams must identify through brainstorming, different areas and materials used in proposed building and landscape
- Talk to contractors and building supplies dealers to gain information

Information:

- Gather and analyze information from contractors and building supplies dealers
- Present information in verbal and written form (including tables and graphs)

Systems:

- Plan out timelines of when different tasks must be completed
- Devise system to monitor if everyone is on schedule and task
- Develop alternate plans when things go wrong (i.e., alternate sources for building supply information, who picks up on tasks if team member is ill, etc.)

Technology:

- Telephone to contact building supply dealers
- Calculator to compute amounts of material and costs
- Computer program for word processing and developing tables and graphs

Less ambitious projects are desirable to begin with. Examples might include team planning and budgeting of a fund-raiser or planning a trip, computing costs of food, travel and lodging, and developing a budget to make the trip possible. Because interpersonal competencies are part of the SCANS guidelines, team efforts are preferable to individual activities. The role of the instructor is to facilitate, provide modeling and instruction as necessary, and to make sure each team member gains experience in each competency area.

Implications for Adult Educators

Much adult basic education is currently delivered to adults on an individual basis. Adults voluntarily receive instruction at basic education centers where they attend with varying degrees of regularity. In many centers, the mode of operation is for the adult to get his or her folder from a file drawer and begin working toward individual goals (i.e. GED preparation, multiplication mastery, etc.). Many learners drop out during the first dozen hours of instruction and only a small percentage exceed 50 hours of instruction per year.

To achieve the level of numeracy skill called for in current workplaces and to implement ideas advocated by SCANS and the Department of Labor implies:

- significant changes in how adult education is delivered and possibly
- targeting instruction upon individuals who are likely to attend regularly enough to participate in group projects which might stretch over several weeks.

Adults who don't have a high school diploma but are already beyond the basic stages of simple addition and subtraction reflected in Level 1 of the NALS could work toward taking the GED test for part of the time they receive instruction and also work on a group SCANS project. The combination of individual and group work may prove to be a motivating mixture which actually improves attendance. Very low level adults, who have demonstrated the ability to attend regularly, could work on simpler SCANS projects.

Collaborative projects between local employers and adult education centers could gather materials used in local workplaces to create simulations of numeracy tasks present in those communities. These could range from taking measurements to using computer print-outs to checking the calculations on SPC forms. The goal is to demonstrate the connection between what is being learned and specific real-world uses of skills.

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COMPARISON OF LITERACY TO NUMERACY ACHIEVEMENT IN A LIFE-SKILLS CONTEXT

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Purpose

This paper examines the relationship between basic literacy achievement and numeracy within an adult life-skills context. The level and proportion of literacy and numeracy achievement will be examined specifically for gender and native language. In addition, the gap between literacy and numeracy achievement will be analyzed on the basis of gender, age, native language and years of schooling. Finally, the size of the gap will be discussed along with some implications for assessment and instruction.

Introduction

For the purpose of this paper reading and math items which appear together on two CASAS appraisal forms will be analyzed. The Greater Avenues for Independence (GAIN) Appraisal and Employability Competency System (ECS) Appraisal will be examined. Both forms are used to assess the basic functional literacy and numeracy level of examinees who are about to enter the workplace.

What is the content of the math skills assessed?

Math items include both basic computation with no reading required and numeracy within a reading context. Items in a reading context involve life-skills applications such as reading a tax form and figuring the tax, studying a coupon and calculating how much can be saved, or reading an appointment book and figuring how to budget time. The following item content descriptions are typical of the ECS and GAIN appraisals used in this analysis.

Basic Computation:
- Add decimal numbers
- Subtract decimal numbers
- Multiply decimal numbers
- Divide whole numbers
- Add common fractions
- Subtract common fractions

Functional life-skills context:
- Interpret and compute wages and wage information
- Use catalogs, order forms, and related information to purchase goods and services
- Interpret information about personal and family budgets
- Interpret appropriate standard measurements for volume and temperature
- Calculate interest rates
- Identify and use information about training opportunities

A sample math item in a functional life-skills and work related context is:

ACME FENCE CO. NAME John L. Smith
Retain this stub for your records

This is a statement of your earnings and tax deductions as reported to the state and federal governments.

Emp. No.	Dept.	Period	Date	Gross Earnings	F.I.C.A.	Federal With. Tax	Number of Exemptions Used to Compute Amount of Withholding Tax	Actual Hours	Bonus	State Tax or Adjust.
616	4	5	1	252.00	14.91	25.40	4	40.-		4.80

If there is no state withholding, the amount shown below represents other adjustments

	Supplies	Misc.	Misc.	Bonds	Credit Union	Contrib.	Insurance	Union Dues	Net Amount This Check
	9.50				5.00	.50	2.50		189.39

38. What is the combined amount for F.I.C.A. and Federal withholding taxes?

A $ 7.91 B $15.40

C $23.31 D $40.31

Description of the two CASAS databases used for these analyses

GAIN database

Greater Avenues for Independence (GAIN) was enacted by the California Legislature in 1985 for the purpose of welfare reform. The GAIN Program contains a full range of employment-related training and supportive services to adults receiving Aid to Families with Dependent Children (AFDC). The GAIN Appraisal is used to identify those participants who need basic education as a component of their employability plan. The appraisal includes assessment in a functional context of reading, math and listening comprehension. The reading portion consists of 30 items, the math portion has 20, while the listening has 12. For the purposes of this paper only reading and math will be examined. The database consists of more than 300,000 response forms collected over a four-year period.

ECS database

The Employability Competency System (ECS) Appraisal was developed by CASAS to provide an initial assessment of a learner's basic functional reading and math skills in a training and employment context. It provides information for appropriate placement into basic skills program and program level, as well as a method to collect basic demographic information in a standardized format. The ECS Appraisal consists of 20 reading and 20 math items. The reading portion assesses a learner's ability to apply basic reading skills to materials that a person is likely to encounter both in job training and in the workplace. The math portion assesses an examinee's ability to perform basic math computation and apply basic math skills in a functional context related to employment. The ECS database consists of 18,186 response forms collected in California.

Interpreting CASAS Scaled Scores

Both of the above appraisals are scaled using Item Response Theory (IRT) which provides a standardized scale of examinee ability and is similar to that used by NALS, GED and SAT. This procedure allows for comparability of test scores because the item parameters are not bound to the test itself but are linked to a more general curriculum scale. The following table is a guide to typical adult learner proficiencies as they correspond to ABE curriculum. Four proficiency levels which will be referred to in this report are identified in Table 1 using CASAS scaled score ranges.

Table 1

Range	Description of Learner Proficiency
Less than 200	• Difficulty with basic literacy and computation skills • Difficulty providing basic personal identification in written form such as on job applications. • Unable to compute wages and paycheck deductions. • Unable to follow simple basic written directions and safety procedures.
200-214	• Possessing low literacy skills. • Difficulty pursuing employment outside entry-level. • Able to fill out simple forms. • Able to demonstrate some basic computation abilities in context.
215-224	• Able to interpret simple graphs and charts. • Able to handle most survival needs and social skills. • Able to demonstrate most basic computation abilities in context. • Difficulty following more complex sets of directions. • Functioning below a high school level.
225 & above	• Functioning at or above a high school entry level in reading and math and can profit from instruction in GED preparation. • Able to perform multiple mathematical functions to solve a single problem in a reading context. • Can profit from instruction at the high school level. • Can meet survival needs, routine work, social demands. • Can usually perform work involving oral directions.

CASAS, 1993

Distribution of Literacy and Numeracy Level by Gender

The gap between literacy and numeracy among males and females is similar: for both sexes only 32 to 35 percent of GAIN participants have numeracy skills at the highest level (225+). An equal proportion, close to 30 percent, are spread out over the next two lower levels. (see Figure 1) In contrast, a much higher percentage of males and females have literacy skills at the highest level. Approximately 80 percent of all females and 69 percent of all males in the GAIN population scored 225 or higher in reading.

The results for the ECS population are somewhat different. (see Figure 2) A higher percentage (48-50%) have numeracy skills at a high school level (225+). Females were slightly better represented than males in both reading and math at the highest level. Also, for ECS, approximately 20 percent more males and females had higher math scores than did the GAIN participants.

It should be noted that the ECS and GAIN databases differ in a number of ways. The ECS population is younger and has less education beyond the high school level, but at the same time has very few who have completed fewer than seven years of schooling. In the GAIN population, however, examinees are more concentrated at both ends of the yardstick. A large number have fewer than 6 years of schooling and a larger number have more than 12. The greater proportion of high math scores in the ECS database is probably due to the fact that the majority of ECS examinees have recently completed 7 to 12 years of schooling, while GAIN participants have a large contingent that either have had fewer than seven years of schooling or who have completed their high school education a number of years ago.

Figure 1

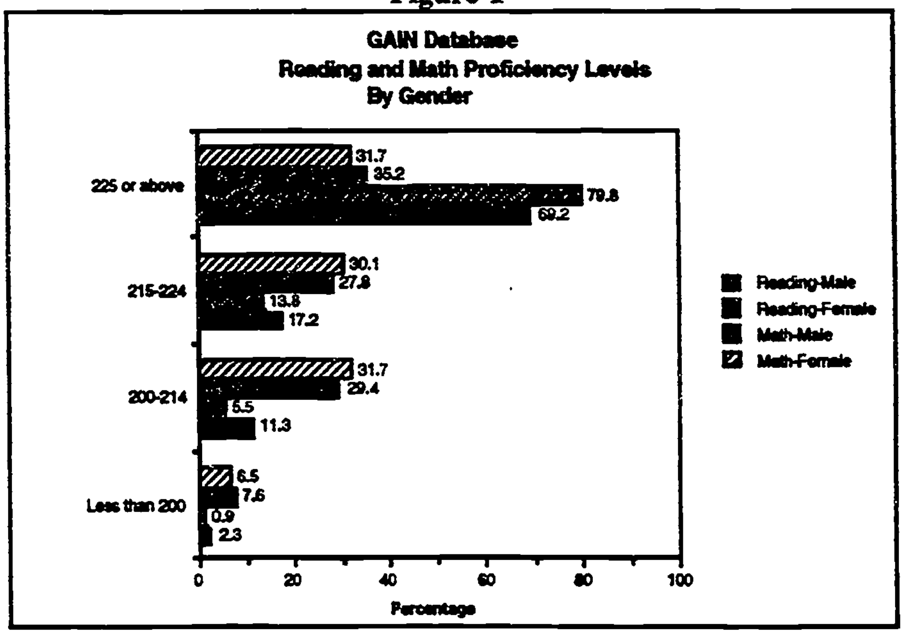
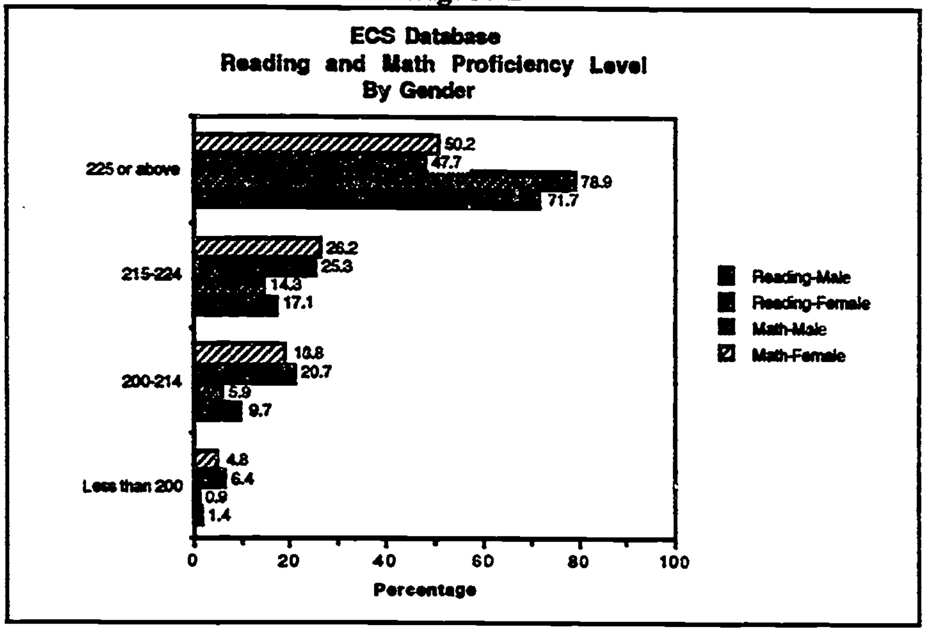


Figure 2



Distribution of Literacy and Numeracy Level by Native Language

Native language seems to be a significant factor in the literacy and numeracy level of adult learners. (see Figure 3) For GAIN participants, 82 percent of native speakers of English scored 225 or above in literacy, while only 55 percent of non-native speakers scored at that level. For numeracy, the difference is almost as dramatic; 35 percent for native speakers versus 21 percent for non-native.

The results for the ECS database were very similar to those for GAIN. (see Figure 4) More than three-quarters of the native speakers scored 225 or above in reading, while a little more than half of the non-native speakers scored that high. The discrepancy between native and non-native speakers appears to hold in the same way for numeracy. Numeracy for native and non-native speakers is also well behind literacy skills overall.

In a separate analysis, the correlation between all math items and all reading items in the ECS database was .58. All of the above suggests that a high level of native language proficiency indicates a probable intermediate level of numeracy, but that language, or literacy proficiency, is not sufficient in and of itself to assume an advanced level of numeracy.

Figure 3

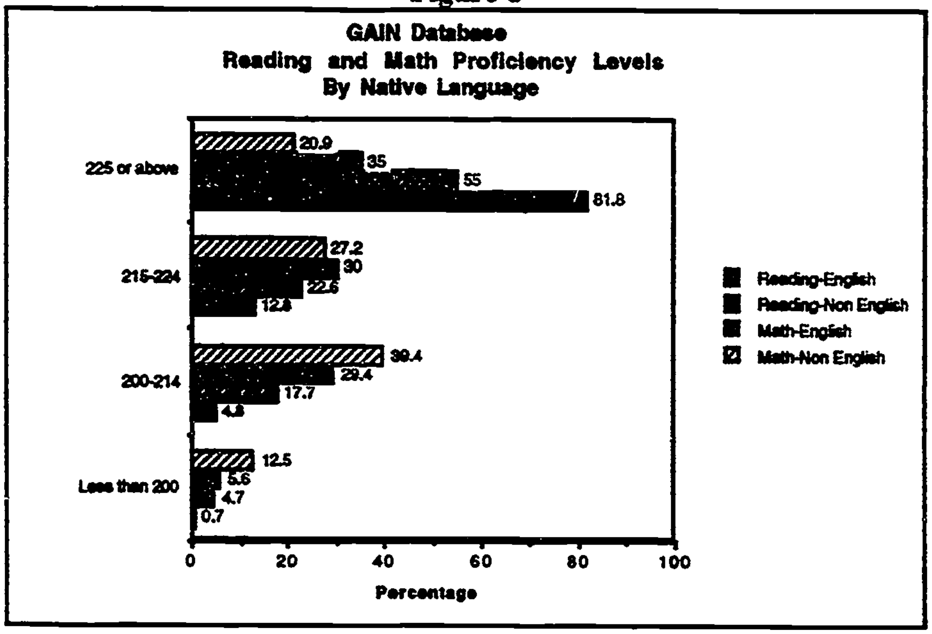
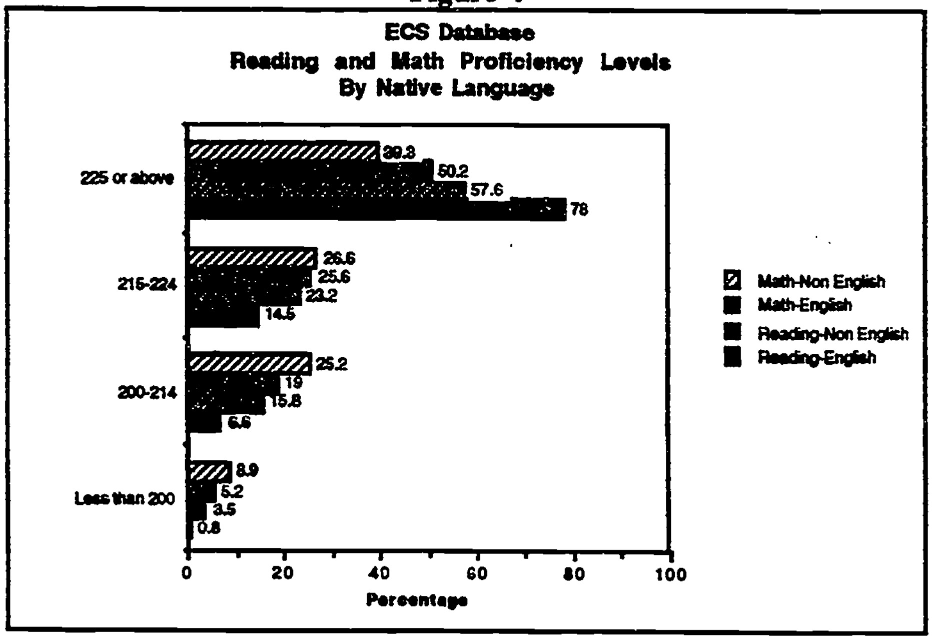


Figure 4



Estimating the Gap Between Literacy and Numeracy

In the following tables reading and math scores were paired in order to estimate the direction and size of the gap between literacy and numeracy achievement. In Table 2, the agreement of reading level to math level can be seen for GAIN participants according to gender, age, native language and grade level. For males, 48.2 percent had a reading score that was at least one proficiency level higher than their math score. In contrast, only 3.7 percent had a math score that was higher than reading. In all categories, the most common agreement of reading level to math level was at the highest range (225+). For example, 36.1 percent of males had similar reading and math scores. Looking at the table overall, not too much difference is seen in the effect of demographic categories on test score. For the most part, learners who had a low literacy level, anyone under 224, had a math score that was at least one level lower.

This holds true for the ECS population as well. (see Table 3) One noticeable exception is that learners whose native language is not English had a much greater proportion of math scores (11.6 versus 3.3) that were higher than reading scores. This is probably typical of the ESL population in general (not well represented in these databases), who have had some numeracy education but are generally lacking in English literacy proficiency.

As stated earlier, the population of the two databases used to make these comparisons differ in a number of ways. The GAIN database comprises welfare clients who are mostly U.S. citizens, many of whom have completed high school, almost all of whom speak English as a native language, and who tend to be older than their ECS counterpart. The ECS database is comprises youth and adults in employability programs, who tend to be younger overall and have had less education. Almost 30 percent of the ECS group do not speak English as a native language. Both these populations are considered to be Adult Basic Education learners as opposed to English as a Second Language and therefore represent, for the most part, the literacy and numeracy achievement level of native speakers.

Table 2
GAIN Database
Agreement of Reading Level to Math Level

	Reading Level = Math Level				Read>Math	Math>Read
	<200	200-214	215-224	225+		
Gender						
Male (N=56,624)	1.4	6.3	4.3	36.1	48.2	3.7
Female (N=107,353)	0.6	3.3	2.3	36.3	56.0	1.5
Age						
15-24 (N=34,734)	0.4	3.9	3.5	35.3	54.9	2.0
25-34 (N=88,217)	0.7	3.9	2.6	35.2	55.8	1.8
35-44 (N=44,795)	1.2	5.1	3.0	38.5	49.6	2.6
45+ (N=9,815)	3.5	8.5	4.1	27.6	51.8	4.5
Native Language						
English (N=151,540)	0.5	3.2	2.4	38.7	53.7	1.5
Spanish (N=13,008)	2.4	8.7	4.9	17.8	62.2	4.0
Grade Level						
0-6 (N=6,831)	9.4	18.0	3.8	9.3	51.8	7.7
7-8 (N=10,561)	13.3	4.2	9.7	2.4	66.7	3.7
9-11 (N=74,835)	0.7	4.8	3.5	26.9	61.9	2.2
12 (N=59,812)	0.3	2.3	2.4	44.0	49.4	1.6
13+ (N=21,184)	0.1	0.9	1.5	65.3	31.1	1.1

(All cells are percentages)

Table 3
ECS Database
Agreement of Reading Level to Math Level

	Reading Level = Math Level				Read>Math	Math>Read
	<200	200-214	215-224	225+		
Gender						
Male (N=9,647)	0.8	5.2	5.9	41.2	40.9	6.0
Female (N=7,430)	0.5	3.2	5.5	45.3	40.8	4.7
Age						
15-24 (N=8,701)	0.5	4.7	7.5	41.9	38.9	6.5
25-34 (N=4,608)	0.8	4.3	3.9	39.8	47.2	4.0
35-44 (N=2,639)	1.0	3.6	3.9	49.3	37.8	4.4
45+ (N=1,487)	1.7	5.8	4.6	43.5	39.0	5.4
Native Language						
English (N=13,144)	0.4	3.5	4.7	45.0	43.1	3.3
Other (N=5,042)	1.7	7.6	8.6	34.1	36.4	11.6
Grade Level						
0-6 (N=132)	9.1	17.4	4.5	5.3	45.5	18.2
7-8 (N=1,255)	1.3	10.3	10.8	20.2	48.1	9.3
9-11 (N=7,236)	0.7	5.0	7.3	35.1	45.8	6.1
12 (N=5,546)	0.4	2.5	4.0	50.2	38.8	4.1
13+ (N=719)	0.1	1.8	1.5	70.8	23.6	2.2

(All cells are percentages)

In Tables 2 and 3 an average of 48 percent of the learners, in both databases combined, had reading and math scores which fell in the same general proficiency level. The most common agreement, by far, of reading level to math level occurred at the highest level (225+). These learners are at a level at which they can profit from high school or GED instruction and presumably have had substantial numeracy education. In contrast, however, more than half of all learners demonstrated a considerable gap between literacy and numeracy, most of which was at the lower three levels.

Summary and Implications

Adults use numeracy in a variety of life-skills contexts in the home, the workplace and the community. The ability to use numeracy in these life-skills contexts all require literacy skills as well as numercy skills. The National Council of Teachers of Mathematics (NCTM) Math Standards and the SCANS commission have identified numeracy skills needed in the future which will require the integration of numeracy with literacy and communication skills to analyze and solve problems and think critically.

This paper presented an analysis of the data from two databases that addresses the relationship between literacy and numeracy. The relationship between basic literacy achievement and numeracy seems to be minimally effected by categories of gender, age or years of schooling. The one exception is for native speakers of English who clearly out-perform their non-native counterparts in both reading and math.

Very little data has been collected in regard to progress in numeracy. However, based on 15 years of research data in literacy an adult learner can be expected on average to move from the middle of one CASAS proficiency level into another in about 200-250 hours. Assuming that a similar progression might apply for numeracy, then 47 percent of the GAIN and ECS population are minimally about 200-250 hours behind in numeracy.

Chapter 4
Proceedings of the 1994 Adult Mathematical Literacy Conference

FEDERALLY SUPPORTED ADULT EDUCATION DELIVERY SYSTEM

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Purpose

The purpose of this paper is to provide a summary description of the major adult education and literacy programs administered under the Adult Education Act and the Adult Education for the Homeless Program established under the Stewart B. McKinney Act and to frame a set of key issues concerning mathematics education in adult education.

Adult Education Act Programs

Basic State Grants

The program of Basic Grants to States is the major source of Federal support for adult basic skills programs. This program, through a cooperative effort between the states and the Federal government, offers persons 16 years of age and older or who are beyond the age of compulsory school attendance under State law, the opportunity to attain reading, writing, and computational skills through the secondary school level of competence. Opportunities are also provided for adults to overcome English-language deficiencies.

The Basic State Grant Program continues to target its services on adults with less than a high school education. Census data (1990) indicate that 44 million persons comprise this target population, of which 4.5 million failed to go past the fifth grade.

Recent Funding History

Fiscal Year	Federal Funding	State/Local Funding
1990	$157,811,000	$630,000,000
1991	201,032,000	711,000,000
1992	235,750,000	NA
1993	254,623,000	NA
1994	254,623,000	NA

While only 15 percent state match was required in 1991, state contributions amounted to over 75 percent of total program expenditures, or more than three times the Federal contribution.

Administrative Structure/Services

The State educational agency is responsible for providing federally required plans and reports, reviewing and processing applications from local providers of adult education services, coordinating programs serving adults, providing technical assistance, establishing priorities for staff development and training and evaluating local programs.

States must give preference to local service providers who have demonstrated or can demonstrate a capability to recruit and serve educationally disadvantaged adults. This group of adults is defined generally as those who demonstrate basic skills equivalent to or below the fifth grade level.

The Adult Education Act directs special attention to programs for incarcerated and other institutionalized adults and to programs sponsored by Public Housing Authorities (PHA). States must spend at least 10 percent of the Federal grant for institutionalized adult programs and a state established minimum for PHA's.

Courses on instruction include Adult Basic Education (ABE), Adult Secondary Education (ASE), and English as a second language (ESL).

Selected Program Facts and Outcomes

Information from annual performance reports submitted by the States for Program Year 1991 indicate the following educational and economic outcomes:

- Over 3.7 million adults were enrolled in adult education.
- Minorities comprise two-thirds of all enrollments.
- Eighty-three percent of program participants were between 16-44 years of age.
- A total of 242,764 participants passed the General Educational Development (GED) test.
- Another 72,834 participants received high school diplomas.
- Over 202,995 entered another education or training program.
- Over 26,938 participants received U.S. citizenship.
- Jobs were obtained by approximately 114,500 participants who had previously been unemployed.
- Approximately 95,000 participants obtained a better job or a salary increase after program involvement.
- Over 53,000 participants were removed from public assistance rolls.

State Literacy Resource Center Program

The purpose of the State Literacy Resource Center (SLRC) program is to establish a network of centers that will:

- Stimulate the coordination of literacy services;
- Enhance the capacity of state and local organizations to provide literacy services; and

- Serve as a reciprocal link between the National Institute for Literacy and service providers for the purpose of sharing information, data, research and expertise, and literacy resources.

Recent Funding History

SLRC grants to states are allocated by formula based on the number of adult, 16 and over who have not completed high school in each state.

Fiscal Year	Federal Funding
1992	$5,000,000
1993	7,856,000
1994	7,856,000

Administrative Structure/Services

Grants for the support of the SLRC program are made to Governors of a state to establish a state center or to the Governors of a group of states to establish a regional center. Contracts to support the creation of new centers are issued on a competitive basis with State or local agencies, organizations, or institutions.

During FY 1992, the first year for the program, all 50 states, the District of Columbia, and Puerto Rico received grants. Of these, 41 states created new state centers. The remaining states expanded existing centers. Eleven states, three in the west, two in the midwest, and six in the East have formed regional centers. Center activities include:

- Improving teaching methods, technologies, and evaluations;
- Assisting public and private agencies in coordinating their literacy services;
- Encouraging partnerships with non-profit organizations and community-based organizations;
- Encouraging innovation in the delivery of literacy services
- Providing technical assistance to state and local service providers;
- Assessing learning style, screening for learning disabilities, and providing individualized instruction;
- Facilitating the training of full-time professional adult educators.

National Institute for Literacy

The National Institute for Literacy was established in the National Literacy Act of 1991. The purpose of the Institute is to enhance the national effort to achieve full literacy by the year 2000 by creating a national support system for literacy and serving as a national focal point for interagency policy development, dissemination of information, technical assistance, program evaluation, and research and dissemination.

Recent Funding History

Fiscal Year Federal Funding

1991	$5,000,000
1992	5,000,000
1993	4,900,000

Administrative Structure/Services

The Institute is administered under an interagency agreement between the Secretaries of Education,Health and Human Services, and Labor. An Advisory Board, appointed by the President, serves the Institute by making recommendations on the goals of the Institute, and the appointment of the Director and staff. The Institute is authorized to engage in the following activities:

- Assist Federal agencies in setting specific objectives and strategies for improving literacy and to assist the agencies in developing ways to measure progress;
- Conduct applied and basic research and demonstrations on literacy,
- Assist Federal, State and local agencies in development, implementation and evaluation of policy with respect to literacy by establishing a national data base and providing technical and policy assistance;
- provide program assistance, training and technical assistance for literacy programs throughout the U.S.;
- Collect and disseminate information to Federal, State and local entities with respect to literacy methods that show great promise;
- Provide a toll-free, long distance telephone number for literacy providers and volunteers; and
- Award literacy fellowships to outstanding individuals pursuing careers in adult education or literacy in the areas of instruction, management, research or innovation.

National Workplace Literacy Program

The National Workplace Literacy Program (WPL) funds competitive demonstration grants for programs involving partnerships between businesses, industry, labor organizations, or private industry councils and education organizations, including State education agencies, local education agencies, and schools (including area vocational schools and institutions of higher education), nonprofit employment and training agencies, or community-based organizations. Each partnership must involve at least one business, industry, or labor organization, or private industry council, and at least one education partner listed above.

Recent Funding History

Fiscal Year	Federal Funding
1990	$19,726,000
1991	19,251,000
1992	21,751,000
1993	18,905,536
1994	18,905,000

Administrative Structure/Services

This national discretionary program is jointly administered by the Division of Adult Education and Literacy and the Division of National Programs within the Office of Vocational and Adult Education. Since 1988, ED has funded over 250 projects that have served 95,000 learners in 42 states.

Projects must provide services that relate directly to the improvement of literacy skills in the workplace. These may include adult basic education; adult secondary education; English as a second language training; education to upgrade basic literacy skills to meet changes in the workplace requirements or processes; education to improve speaking, listening, reading, and problem solving, and support services for those receiving basic skill instruction including education counseling, transportation, and child care.

Stewart B. McKinney Homeless Assistance Act

Adult Education for the Homeless Program

The purpose of this program is to provide discretionary grants to State education agencies to enable them to implement, either directly or through contracts or subgrants, programs of basic skill remediation and literacy training for homeless adults.

Funding History/Last Five Years

Fiscal Year	Federal Funding
1990	$7,397,000
1991	9,800,000
1992	9,600,000
1993	9,500,000
1994	9,500,000

Administrative Structure/Services

Only State education agencies are eligible to apply for the program. States compete for funds, and those that are funded make subgrants to local education agencies, community colleges, and shelter providers to provide literacy training to homeless adults.

In FY 1992 over 50,000 homeless adult were served. Adult education services are provided to help homeless adults increase their employability, earn a GED or some other adult diploma, or reach personal or economic objectives. Programs are required to develop cooperative relationships with other service agencies to provide an integrated package of support services addressing the most pressing needs of homeless individuals at or through the project site.

A number of states have produced specially designed materials on how best to provide literacy and basic skills services to homeless adults and these manuals and curriculums are disseminated widely among all states.

Implications For the Field

The AEA represents the primary Federal investment in adult education and literacy and, as such, provides much of the policy and programmatic framework of the publicly supported adult education delivery system at the state and local level.

The major implication for those involved in mathematics instruction as, indeed, for everyone interested in adult education and literacy is the fact that in the next 18 months a new Adult Education Act will be written by Congress. The AEA expires June 30, 1995 and activity around the reauthorization of the Act has already begun. This reauthorization will set the framework for achieving National Education Goal #5 as well as defining the role of publicly supported adult education in the 21st century.

Although many issues will be explored during the reauthorization of the AEA, much of the discussion will be framed around four critical areas: 1) higher standards, 2) increased accountability, 3) teacher development, and 4) better use of technology. Although these are comprehensive issues please think about them in relation to the teaching of mathematics in adult education programs.

- Higher Standards -- The development of world-class academic skill standards will frame "what" and "how" the core academic subjects will be taught well into the 21st century. Critical questions for reauthorization include how the AEA will assist practitioners in articulating these world-class standards into the instructional and programmatic framework of adult education? Should there be different or common standards for in-school and out-of-school populations?
- Increased Accountability -- Continuing Federal support for adult education must be coupled with improving overall program quality and effectiveness. Improved accountability systems should reflect and be responsive to the broad spectrum of adult education clientele: adult learners, supporting agencies, program partners, employers, and the community. How can the Federal government promote the adoption of program accountability measures which demonstrate appropriate high performance programs? How can Federal support be structured to result in and reward educational improvement? What are the expected outcomes of adult education? Who should define program outcomes, the publics which fund the program or the adult learners who need and use program services, or both?
- Teacher Development -- If, as many believe, a successful delivery system is built upon a cadre of full-time, professionally trained adult education professionals, what must be done to support the development of quality staff? Should the Federal government create incentives to encourage teachers to go into adult education on a full-time basis? What kind of research should be supported to improve teacher training? What must be done at the State and local level to provide sustained and intensive high-quality professional development in the core academic subjects?
- Better use of Technology -- The traditional, tutorial/classroom-based approach to adult education may not be the best method for attracting and retaining adult learners. Incorporating new technologies, especially through distance-learning options may offer expanded access to adult learners. Should the Federal government

encourage and support the use of more technology in adult education? How can technology be used in ways to support the individual attention required by so many adult students? Where can limited adult education technology resources be targeted to achieve the most benefits.

A reauthorized Adult Education Act will provide a "roadmap" to meet the new demands for life-long learning. This "roadmap" will be only as good as the input from those who help draw it. Think about these and other issues affecting mathematics instruction in adult education and get involved at the state and national level in redesigning the Adult Education Act.

Chapter 5
Proceedings of the 1994 Adult Mathematical Literacy Conference

CAN THE DELIVERY SYSTEM DELIVER? REALITIES OF NUMERACY EDUCATION IN ADULT LITERACY PROGRAMS

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Purpose

This paper examines realities of numeracy instruction in adult literacy programs in the United States. Implications for national reform efforts in numeracy education are discussed.

Adult literacy programs and mathematics instruction

As the mathematics education and adult education communities, as well as other stakeholders, begin to contemplate ways to improve adult numeracy education, it is important to ask, "What is the nature of the delivery system within which adult education in mathematics takes place?" This paper examines six aspects of the current delivery system pertaining to numeracy education: (1) extent of mathematics instruction, (2) staff preparation, (3) assessment, (4) instructional resources, (5) use of computers, and (6) diversity in program organization.

Two sources of information were used in this paper to examine the above issues. Some information of a general nature was obtained from reports published by federal or state agencies which oversee adult education. As such reports usually provide little or no information on mathematics education for adults, the discussion is supplemented by results from a recent survey on numeracy related activities in the United States, conducted by the Numeracy Project at the National Center on Adult Literacy (NCAL). This survey encompassed a nationally representative sample of 350 programs from 15 states which provided instructional services to over 750,000 adult learners in 1993-1994, and yielded data regarding four of the issues identified above: extent of math-related activities, staff preparation, assessment frameworks, and use of computers for teaching math. (See Gal and Schuh, 1994, for a full report of survey results).

1. Extent of math-related instruction

How many participants in adult literacy programs engage in some math-related activity, and at what levels? Data on these issues should set the stage for any discussion of staffing and teacher enhancement plans and of allocation of resources at the local, state and federal levels. Yet, official attendance or participation statistics do not describe program activities in terms of their *content*. Rather, state or federal reports normally characterize activities in programs in terms of magnitude or amount, e.g., the number or characteristics of students receiving instruction in programs, rates of recruitment and retention of students; or expenditure levels.

The Department of Education (1993) reported that in the 1990-1991 program year (the most recent year for which data are available), 36% of the almost 3.8 million adults served by state-administered programs studied at the ABE level (adult Basic Education, equivalent to grades 1-8), 32% at the ASE level (Adult Secondary Education, usually involving GED preparation), and 32% in ESL (English as a Second Language) programs. (It is important to note that the above figure of 3.8 million students relates only to students in programs funded in whole or in part by the Department of Education, and does not cover adults studying in programs funded by companies, private sources, or by other federal agencies such as the Department of Labor).

One can assume that almost all ASE students receive some math instruction, as GED preparation normally involves work on the math section of the test. Yet, no official data exist about the extent of math-related instruction among ABE or ESL students, or among students in individual tutoring. The NCAL survey has uncovered the following with regard to the number of students engaged in math learning in the above three contexts:

• *ABE/ASE.* Of the more than 750,000 students who attended the 350 programs surveyed, 30.4% studied at the ASE level, and an additional 50.8% reportedly studied some math at the ABE level, for a total of 81.2% of adult learners receiving some math-related instruction.

• *ESL.* Roughly one third of all non-GED students who did receive some math-related instruction were ESL students. This is of importance, given that mathematics instruction with bilingual students or students from countries using mathematical routines different than those imparted by American K-12 schools, may require a somewhat different approach than the one employed in mainstream American teaching.

• *Tutoring.* Programs with tutoring activities overall reported that almost 40% of tutored students receive some math instruction. This figure is also of interest, considering that programs appear to allocate little time to math instruction in their tutor-training workshops (see below).

2. *Teachers and their preparation*

Given that a majority of adult students appear to receive some amount of math instruction, it is important to examine the qualifications and training of adult educators who teach mathematics. However, only sporadic information is available in official reports on this critical issue.

A recent study of staff development in ABE and ESL programs across the U.S. (Tibbetts, Kutner, Hemphill & Jones, 1991) estimated that volunteers, who are engaged in one-on-one tutoring, constituted between 25% and 75% of the teaching force depending on the state, and receive between 8 and 20 hours of preservice training prior to working with adult students. Tibbetts et al. (1991) suggested that preservice training is likely to focus mostly on reading and writing, not on math, but provided no estimates of time invested in preparing tutors to teach mathematical issues. No data could be found in official reports (e.g., Pelavin Associates, 1991) on qualifications of paid teachers (not volunteers) in regard to mathematics instruction, or on math-related pre-service or in-service activities. In this context, results from NCAL's survey provide important supplementary information, as follows:

• *Employment status.* Of all teachers employed by programs, 85% were part-time. (The comparable national figure for 1990-1991 is 88%). The fact that the salaried teaching force in adult education is comprised mainly of part-time, hourly-paid teachers is noteworthy; such teachers may be less likely than full time teachers to participate in inservice activities, if available, due to lack of financial remuneration or due to the need such teachers have to work in additional jobs.

• *Teacher certification.* There is no direct way for measuring teachers' qualifications for providing numeracy education, as no national standards exist in this area. Thus, certification figures in NCAL's survey (i.e., the number of teachers in a program who are certified in math education) were used as a proxy measure. Certification of part-time teachers is of interest as it can shed light on the relative importance that programs place on having a qualified teaching force in mathematics.

The survey found that markedly fewer teachers are certified in mathematics compared to other fields. Programs overall reported that 29.2% and 25.7% of teachers were certified in adult or elementary education, respectively, compared to about 7.8% with certification in mathematics education. (It is important to note that there are no known graduate courses focusing on math instruction to adults).

The percentage of teachers with math certification was found to be low regardless of the extent of math-related instruction in a program, either at GED or non-GED levels. Even in programs which reported that 100% of their students receive some math-related instruction, few teachers were reportedly certified in mathematics education. In other words, programs do not appear to increase hiring of teachers with certification in math education even when the need for such hiring is manifest in light of the programs' educational activities.

• *Preservice training.* Not all programs can be expected to provide extensive preservice training to new teachers. It is possible, for example, that funding for a program emphasizes instruction in reading/writing only, that a program serves students for whom math is of low priority, or that in some programs a majority of teachers may already have an adequate preparation for teaching mathematical topics. With this said, the NCAL survey led to some surprising findings.

Preservice for teachers overall ranged from 0-30 hours, with a median of 6 hours. Only 46% of programs allocated any time to math instruction issues in pre-service training for teachers; of these programs, 83% allocated no more than 2 hours to math instruction issues in preservice training. The percentage of preservice time devoted to math did not increase even in programs reporting that most or all of their students were receiving some math instruction.

Only 121 programs provided data on pre-service training for tutors; the median duration of such training was 10 hours. Of these 121 programs, 93 (45.6%) addressed math issues in tutor preparation. The actual number of hours devoted to math issues was very low: 71% of the programs who reported any math-related tutor preparation activities spend 2 hours or less on this topic, with only 29% spending more than two hours.

Before leaving the topic of teacher preparation, one should not overlook the implications of diversity in learners' goals for teacher training. In most programs, adult students participate on a voluntary basis; they usually seek to develop, e.g., functional skills, work-related skills, academic skills that can help them to obtain an educational diploma such as the GED, skills needed to help their children with homework, etc. The (in)ability of programs to fully satisfy multiple learner goals may be one of several factors causing learners to either drop out early, or to not engage at all in adult education. These varied goals and their potential link to student retention have implications for the range of expertise needed by teachers, and thus for the nature of preparation that should be expected of, or provided to, teachers and tutors.

3. *Instructional resources*

What instructional resources are available for use by teachers and tutors? Since a majority of teachers engaged in math instruction appear to have little or no formal preparation in this area, it is important to examine the nature of the materials which they can use to support and inform their work.

Commercial textbooks or workbooks are widely available and heavily promoted by publishers. They appear to address, at least in part, the rich assortment of work and everyday contexts requiring some sort of quantitative skills. However, even a cursory examination of such resources reveals that many resemble traditional drill-and-practice K-12 textbooks and that they include many repetitive computational exercises. The NCTM (1989) recommendations for changes in the scope and nature of mathematics teaching and assessment seem to have gone unnoticed by those who develop curricular materials for the adult market.

Some states and agencies fund development of materials suited for particular learner populations, believing they are more appropriate than commercial materials. This is often done through Section 353 funds which are available for special demonstration projects or for staff-development purposes. Such locally-developed materials are often available through state literacy resource centers. However, development and dissemination of materials in different states has so far not being coordinated, so duplication of effort is quite common.

4. Assessment

How do programs assess students' mathematical skills? Clearly, the nature and quality of the method(s) used to assess learners' (mathematical) skills affect programs' capability to determine instructional needs and create instructional plans regarding mathematics learning. Assessment frameworks used by programs also play an important role when funders require that programs supply data on student progress to be used for evaluation of program effectiveness.

It has been known for some time that adult literacy programs often use standardized tests for placement purposes and for reporting of learning gains (Sticht, 1990); the standardized tests most commonly used (e.g., TABE, ABLE) include math-related subtests with multiple-choice items. Another available test, the CASAS, examines functional skills by using integrative functional tasks, including some involving number-related skills (see chapter 3).

To obtain updated information specifically about assessment practices related to mathematical skills, the NCAL survey asked programs to report the type of test(s) used to assess mathematical skills of incoming students at the intake stage. Key results were:

• A total of 72.6% of programs used one or more standardized tests, with the TABE being the single most widely used test (in 48% of all programs); other commonly used standardized tests include the ABLE, WRAT, and GED practice test. (Notice that the GED practice test has different characteristics than the TABE or ABLE, which purport to provide grade-equivalency scores for a wide ability range, but do so mostly with math items emphasizing computational skills and mastery of mathematical procedures, and minimizing the involvement of literacy skills. In contrast, the GED practice test, which was designed for use only as part of the preparation of students for a high-school equivalency exam, uses items focused in a specific difficulty range, puts a somewhat greater emphasis on items involving problem-solving and estimation skills, and provides no grade equivalents).

• About 15.9% of programs used the CASAS test, which focuses on functional skills through the use of real-world materials or tasks: 6.4% of programs use only the CASAS, and an additional 9.5% use the CASAS in combination with the TABE or some other standardized tests. These data are compatible with earlier findings showing that a majority of adult literacy programs rely on standardized tests (Sticht, 1990).

• 12.0% reported using no math-related assessment for incoming students; roughly three quarters of these programs were small programs emphasizing mostly reading and writing skills, yet the other programs claimed to teach all basic skills, including mathematics.

• A total of 24.8% of programs used one or more locally developed tests; this figure is comprised of 9% of programs which used only locally developed tests at the intake stage, with the other 15.8% using such tests in combination with one or more standardized tests.

• Student self-assessments were used by 9% of the programs in combination with other assessment methods, but never as the only assessment tool.

5. Technology

Recent reports highlight the potential benefits that literacy educators can obtain from increased use of technology (e.g., U.S. Congress-Office of Technology Assessment, 1993). Specifically with regard to the use of computers for educational purposes, the availability of computer programs for teaching mathematics at the K-12 level has increased dramatically in recent years, garnering a broadening base of research support (Kaput, 1992). Yet, it is unclear to what extent adult literacy programs are using computer technology for mathematical education purposes, and whether teachers and programs have the knowhow needed to incorporate new technologies into ongoing instructional practices.

Results from NCAL's survey reveal a wide gap between the availability of computer software and the actual number of non-GED students who use it. Overall, 78% of the programs reported that they have some math-related software. However, the average percentage of ABE students reported as using math software was only 27.8%. Thirty one percent of programs reported that *none* of their ABE students actually used available software, and only 9.4% programs reported that all of their ABE students have used math software. These data are compatible with recent findings by the Office of Technology Assessment, that no more than 15 percent of literacy programs in the U.S. regularly use computers for instruction, and that many do not use them at all.

6. Program diversity

There is an enormous diversity in the way adult education activities are organized and funded. This diversity may be larger than that found in K-12 systems and needs to be considered, especially if reform efforts from K-12 contexts are used as a model (see chapters 9 and 10 in this volume) to improve adult mathematics education.

Adult education activities in different localities are organized and delivered in varied ways, for example: through school districts, through adult school systems, by independent (and often quite small) community-based organizations, based in community colleges which may have many satellite sites and sub-sites, based in correctional facilities, conducted within factories, or subcontracted through Private Industry Councils. States and local education agencies exercise varying degrees of control (or lack thereof) over curriculum, instruction, assessment, or staffing and staff training, as funding may come from a multiplicity of sources, both public and private.

Further, the term "program" covers a diverse universe of service providers. For example, some programs may operate from a single site and be based mostly on volunteer operations. At the other extreme may be a large network of quite independent entities which report to a central office; an example is a community college operating many satellite sites serving thousands of learners per year, and employing a mix of part-time and full-time teachers. In the NCAL survey, small programs (less than 600 students per year) accounted for roughly half of all programs surveyed, but altogether served only about 5% of the students serviced by all programs in the sample. About half of the small programs operated from a single site.

One suspects that a reform process in adult numeracy education would work, at least in part, in a top-down fashion; this scenario is likely in light of the leverage that funding agencies may have on the adult education system. Under such circumstances, the organizations within which teachers work may play a major role in mediating the effects of any top-down reform and in determining the success, or lack thereof, of any change effort. (See Ball, 1990, and others in the same issue of *Educational Evaluation and Policy Analysis* for an analysis of the effects of the California Mathematics Framework on schools and teachers).

The nature of the basic organizational entity in adult education, a "program," may be quite different than that of a "school" in a K-12 context. Also, as noted earlier, the reliance on part-time teachers and volunteer tutors for literacy instruction make for a teaching force which is presently not accessible in the same way as K-12 teachers. These conditions reduce the likelihood that a national reform effort will be successful in delivering its messages to teachers and programs through centrally developed teacher training activities and new instructional resources. Given the relative autonomy and wide diversity of adult education programs, it may be unrealistic to expect a reform process to have a significant impact on the field if it seeks to create a change only in a top-down fashion. This author suggests that, in addition to investing in top-down activities, one important objective of a national effort for reforming adult numeracy education should be to encourage grassroots efforts and to support networking and a dialogue among teachers and tutors.

Implications

Many questions about the quality of mathematics education in literacy programs in the United States are raised by the above discussion and by findings from NCAL's survey. A gross mismatch appears to exist between the (high) number of students who receive math instruction and the (low) level of formal preparation of teachers to deliver instruction in mathematics, as revealed by data about certification and preservice training. It appears that a majority of teachers in adult literacy programs are *literacy* teachers who acquire math-teaching skills informally on the job, rather than through formal training. While data on teacher certification and preservice training are far from being complete and reliable indicators for teachers' competency, the findings raise doubts regarding the level of expertise in teaching mathematics that adult educators presently have. Unfortunately, systematic training in this area is presently unavailable either in academic institutions or via the adult education system.

Most programs surveyed by NCAL reported that standardized tests, especially the TABE, are being used to assess mathematical skills of incoming students. However, these tests have many shortcomings (Sticht, 1990) and provide only limited information about key mathematical skills (e.g., problem-solving, estimation, number sense, "communicating mathematically") emphasized in suggested reforms in mathematics education (NCTM, 1989) and in descriptions of skills required in modern workplaces (Carnevale, Gainer & Meltzer, 1990; SCANS, 1991).

The emerging picture is thus that a majority of adult educators have little formal training, or access to training, in mathematics instruction, and rely on tests which do not provide data on key mathematical problem-solving and communicative skills. Under such circumstances, many educators may be unaware of important skill areas in which their learners could benefit from additional instruction, and may be unfamiliar with proposed reforms in the goals of and methods for instruction in (adult) mathematics education (Gal, 1993).

The above discussion suggests that the adult education system should rapidly develop and make available to adult educators a comprehensive system of professional development, taking into account the diversity in organizational structures and the characteristics, deployment, and training needs of the teaching force. In addition to general issues in the teaching of mathematics to adults, findings from NCAL's survey point to the need to provide training in math instruction for ESL students, training in the use of computers or other educational technologies for teaching mathematics to adults, and training about the limitations of current assessment instruments and in the use of alternative assessment methods.

The nature and adequacy of the reporting system in adult education is a separate but critical issue which is highlighted by the above discussion. As argued earlier, reporting schemes presently in use by adult education agencies focus on administrative indicators that do *not* characterize the nature of activity in different instructional areas, such as in mathematics. This situation may explain how the fact that over 80% of adult learners engage in some form of math learning has so far escaped the attention of decision makers at the federal and state levels, and might in part account for the paucity of training opportunities in this area. It is recommended that the reporting scheme in adult education be examined and changed so that program reports also address the *content* and not only the *amount* of activity.

The common practice of reporting student achievement or gain in terms of *grade-level equivalents* should also be examined. Such reporting usually refers to grade-level in reading, not in math, and thus may mask important information or changes in student numeracy skills. Such reporting will increasingly make little sense as emphasis in mathematics education shifts to integrated instruction involving functional elements. The skills developed via such instruction do not easily lend themselves to characterizations in terms of grade levels. The use of grade levels assumes that all learners follow the same curriculum and progress in a strictly linear fashion from topic to topic. This assumption is far from being true in the case of adult learners, who come to the classroom with diverse backgrounds and with multiple and different learning needs.

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Chapter 6
Proceedings of the 1994 Adult Mathematical Literacy Conference

ISSUES AND BARRIERS IN WORKPLACE NUMERACY EDUCATION

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Purpose:

To share experiences of a workforce development project and point to questions of relevance to adult numeracy education.

Workplace Education Program Development

We do not need to prove that a better educated workforce is a better skilled workforce. That is a given. The difficulty with education programs in the workplace in the past, however, is that they were usually very generic and did not address the specific educational needs of employers and/or workers. Adult educators visited a worksite, asked for a room in which to work, asked employers to buy workbooks, sent out flyers to enroll workers and went into the workplace education business without asking many questions about need. This kind of education program fit into the workplace of the past that used workers for their brawn rather than their brain. GED or ABE programs were held on-site, but management rarely connected the impact of these classes to production. Education remained an abstract that had no specific tie-in to the job.

We know that the workplace of today has specific educational requirements. In the new workplace, education and training are conceived of as part of a long-term strategic plan for on-going improvement. Companies are beginning to put premiums on developing and realizing the full potential of the entire workforce. Education in the workplace is more than remedial. Just offering a generic curriculum will not work. Companies are now focusing on building skills for continuous improvement and flexibility as well as on job-specific skills.

To determine specific needs our program staff interviews a random sample (usually 20-25%) of company employees to determine how more education might help workers on the job and to determine what the specific content of classes ought to be. Interviews at most companies almost always indicate a need for some remedial work. Many workers want to "brush-up" on their basic skills, especially mathematics. But in addition, we find job-specific applications of these skills are desperately needed, such as having a better understanding of fractions in order to read and follow blueprints, or to measure lengths of material.

This data, generated from the workplace itself, is instrumental in convincing management that investing in a workplace education program will pay off for the company. This approach to program development, stressing application-based, customized curriculum, sells education to a company and its employees. These goals are more than basic skills goals;

they are economic development goals. Numeracy in the workplace goes beyond learning abstract mathematical computations from a workbook in some back room of the plant. It becomes a dynamic process that affects the worklife of the employer and employee. Workplace education is perceived as action, not preparation for it.

Program Goals

While interviewing employees suggests the specific job applications of numeracy skills, the interviews often identify educational goals of employees beyond those goals related to work. These additional goals cannot be ignored. After all, with most workplace education programs being voluntary, it is the attention paid to individual goals that most often retains adult workers in class over a long period of time. Sheryl Greenwood Gowen identified these differences in employer and employee goals in her work, The Politics of Workplace Literacy. She notes that "Most employees come to learn new skills. But few of them see themselves as confused, unorganized, or incompetent -- definitions provided by management. Rather, they come to class for their own reasons. They resist the program's narrow categories and attempt to learn what they believe they need to reach their own personal goals."

Experience has shown us that workers relate to meaning. They are willing to learn what they perceive to be meaningful to their lives. Any instruction in numeracy must be within this context of meaning--it must engage the function of the mind of the adult learner.

Teaching

Teaching adult workers numeracy for the twenty-first century is a huge challenge. Workers have returned to a classroom bringing many work and life experiences. They attended school in an era where critical thinking skills and problem solving strategies were rarely emphasized and not labeled as such if they did happen to be taught. Workers have memorized algorithms and numeracy facts and have little understanding of the sense and value of mathematics and how it can be applied to their work. Most understand their need for mathematical literacy and good problem solving skills but are so math anxious they feel defeated from the beginning.

These workers are very dependent on how they were taught in school, even if those methods weren't methods that suited their particular learning styles. Some have even been taught incorrectly. These learners require exceptional teaching skills. They need quality instruction. They need to be interviewed so that their learning styles can be identified and personal instruction strategies planned. They need assurance of confidentiality. They need instruction that is different from what they experienced in school.

In his paper, "Learning for Mastery," Benjamin Bloom writes that "Most students (perhaps over 90 percent) can master what we have to teach them, and it is the task of instruction to find the means which will enable our students to master the subject under consideration." The workplace does not merely want its workers to learn new skills. Workers *need* to learn them. As columnist William Raspberry says, "They (managers) have no interest in handing out gold stars or distributing scores along a bell-shaped curve. They need us--all of us--to become competent at the system they've introduced. And because they do, they teach us differently than we were taught in school."

What is different about teaching in the workplace? For one thing, teachers must believe in mastery learning. After all, the livelihood of workers depends on whether or not concepts are mastered. Bloom defines five characteristics of mastery learning: aptitude, quality of instruction, ability to understand instruction, perseverance, and time allowed for learning. What do these characteristics of mastery learning look like in the workplace?

Aptitude. According to John Carroll, our aptitude is the amount of time it takes to attain mastery of a task. Workers can't fail. It will take some weeks to master what some will comprehend during a five hour session. It will take some workers more effort, time, and help to achieve mastery than it will other workers. But everyone must learn it because the company will be unable to function unless its employees are successful.

Quality of Instruction. Quality of instruction has to do with how mathematical concepts are presented, explained, and ordered in a learning sequence. And while there is no standard classroom situation in the workplace, good teaching will always be the key to learning! Providers of adult education may or may not have adequate skills and training to teach mathematics. If providers are inadequate, learners will disappear. If providers are inadequate, the goals of the numeracy conference will not be achieved. To enlist and retain adults in learning situations, instructors must be innovative, flexible, and compassionate. They should be able to demonstrate a solid knowledge of the subject to be taught. Materials such as math manipulatives can visualize concepts for the learner and calculators and computers can take the tedium out of computation. However, using manipulatives and technology doesn't guarantee success. The success of any or all of these lies in the competency of the provider.

Training should be readily available for providers. Since 1989 when the National Council of Teachers of Mathematics (NCTM) Standards were published, training opportunities for teaching mathematics using manipulatives, technology, and alternate forms of teaching and assessment have flourished. Instructors in the workplace must have this training. Traditional teaching with "canned" curriculum may not be acceptable to workers who have no choice but to learn.

Ability to Understand Instruction. One item for consideration in a master-learning strategy is to find ways of reducing the amount of time required for slower learners. Our experience has shown that a combination of several variables has led to a reduction of required time, although we have no empirical data to prove it. For instance, linking basic skills to job applications has helped. Using a variety of instructional techniques, such as math manipulatives, has helped. Understanding and using learning styles have helped. Breaking down barriers between students and teachers has helped. Understanding the politics of the workplace has helped. Helping workers learn to learn by encouraging them to seek help from colleagues who have it down pat through asking questions, taking notes, and looking over shoulders has helped. Teaching workers how to access resources and manuals has helped. Since no one will be asked to recite anything from memory, job aids (formerly called crib sheets) can be referred to without guilt.

Perseverance. This is the amount of time the worker is willing to spend in learning. In the workplace, employees generally are willing to persevere an unusually long time in learning, provided instruction is appropriate for them and they perceive the relevance of instruction to their job or to their life. If these two conditions are not present, they will usually do one of three things: stop coming to class, finish their work as quickly as possible, or subtly resist by losing their work, leaving it at home, or changing it into something that is relevant. Most often, they drop out.

Time Allowed for Learning. Workers must have adequate amounts of time to master the concepts necessary for their jobs. Teachers must remember that aptitude, or time necessary for learning, varies from worker to worker. Time must be made available. Time alone, however, is not the final key. If a worker is frustrated in learning, s/he must reduce (in self-defense) the amount of time devoted to learning. All students sooner or later give up a task if it is too painful for them. Workers need a strategy for mastery learning that will provide adequate time, instructional resources appropriate for them, frequent feedback, and specific help.

Materials

It is a plus for providers of mathematics/numeracy literacy that we are working in an age of availability of math manipulatives and technology. Math manipulatives provide a hands-on, visualized approach to most math concepts. They allow workers to approach mathematics with something concrete, something they can hold in their hands. Workers can build concepts or take concepts apart with manipulatives.

If teaching numeracy begins with concrete examples of a concept, the learner can be directed in time to semi-abstract and then to abstract thinking. When a provider begins lessons with pencil and paper, the worker is actually dealing with abstract concepts. If the worker doesn't understand them, where does the worker go? Where does the provider go? Providers should build concepts from the bottom up, and instead of backing into the concrete, providers should begin with it.

Ninety percent of workers interviewed at one job site admitted having difficulty reading a tape measure that was issued to them when they were hired. As a result, one module of instruction centered around reading, understanding, and using this work tool. Skills assessments had shown that worker understanding of fractions was minimal. A ruler divided into 32nds was mindboggling. Instruction began with manipulatives using base ten blocks and fraction rods to illustrate equivalence relationships. With this approach, the workers could see illustrations, use manipulatives and make analogies. Still, each day a portion of instruction returns to what workers know, which is pencil and paper mathematics.

How manipulatives are introduced to workers is extremely important. Because these materials are new to workers, they can be perceived as being something that must be endured until they get to real math. To ward off resistance, we do the following:

1. *Talk with learners about learning styles.* We administer learning styles inventories and talk about the different styles of the workers in class. We give concrete examples of how knowledge of learning styles might affect instruction and learning in their own class. These discussions might include why some workers like to work alone while others prefer groups; why some learners offer responses quickly while others need time to think before responding; and why some learners understand math using pencil and paper while others need concrete examples. Once learners have these understandings of the differences in their groups, they are more tolerant of different approaches to learning. Sometimes we are able to say we are teaching a concept a certain way because of the learning styles of Dick, Jane, and Sally, who are group members. A critical by-product of these discussions is the newfound awareness on the part of workers regarding the teaching/learning process. They often begin to give themselves permission to ask for what experiences they need in class; they often give themselves permission to move more slowly through the learning process than they had before; they are not trying to "keep up" with someone sitting next to them; they come to understand the cooperative nature of learning rather than the competition so many of them

experienced in the past. In addition, some workers have expressed a blossoming awareness of the learning styles of their children. It is interesting to me that we, as educators, have not generally shared what we know about teaching and learning with learners. Often awareness of this information alone allows workers to relax in class, which as we know leads to more openness to learning.

2. *Define what concrete learning and abstract learning are in words that learners understand.* Invariably most workers will tell us that they need a hands-on approach to learning. As workers begin to accept that this is an acceptable mode of learning, they quit torturing themselves with how they "ought" to be learning, and begin to experience some of the satisfactions of learning that many of us have enjoyed our whole lives.

3. *Talk about learning anxiety, specifically math anxiety.* As learners share "horror stories" with one another about specific educational experiences that left them scarred in some way, they begin to feel less and less that they are the sole culprit in why they simply could not learn mathematics. Most all workers have taken full responsibility for why they could not learn. They invariably feel that something is wrong with them. These discussions allow them to see that many of their peers had similar experiences; they begin to see often that school-based learning as we define it simply was not for them. With a decrease in anxiety, motivation to learn returns and risk-taking behaviors are such as asking or answering questions come more often.

4. *Finally, we just say, "Trust us. This will help you."* For learners who have heard these words before or have been the recipient of actions that communicated this concept, only to have failed, these words can have no value at all. We don't say this until we have established the kind of rapport with workers in which they have seen commitment to their learning and respect for them as individuals demonstrated on a day-by-day, moment-by-moment basis. Educators sensitive to learners will know when this statement will be effective.

Regarding the materials that technology has brought to teaching numeracy in the workplace, computers and calculators specifically should not replace thinking skills but assist and enhance them. Technology allows the worker to think, to make conjectures, to problem solve without the rigor of computation and therefore should be utilized in teaching mathematics in the workplace. If one of our primary goals in the teaching and learning of mathematics is to produce adequate problem-solvers, learners should not have to do numerous, tedious, time-consuming calculations. There are calculators that display a complete problem instead of one digit per keystroke. There are calculators that find common denominators and reduce to lowest terms. There are calculators that analyze, calculate, and graph statistical data.

The new technologies introduced within the plant is the reason most companies feel the need for workbased education. This is a technological age. It doesn't make sense to deprive workers of the tools of today's workplace while these same workers are becoming trained for that workplace.

Much of the work done with manipulatives and technology lends itself to group work. Learning how to work in a group transfers directly to the workplace because more and more frontline workers find themselves members of self-directed work teams. In these teams they must incorporate critical thinking skills and problem solving skills to complete their tasks. It makes sense, then, to model these group behaviors in a workbased education class as much as possible. If workers learn to learn by getting and receiving help from co-workers through asking questions, taking notes, and helping one another, then they are learning key teamwork skills as well.

Assessments

Repeating William Raspberry's earlier quote, "They (managers) have no interest in handing out gold stars or distributing scores along a bell-shaped curve." Evaluation in the workplace should focus on the learning *process* rather than on a judgmental product. The goal of instruction is for workers to become competent at the system their company has introduced. It's almost as though the NCTM Standards addressing assessment were written with the workplace in mind. The standards say the main purpose of evaluation is to help teachers better understand what students know, and that assessment should not be formidable. Evaluation procedures should focus on what workers know rather than what they do not know.

Evaluation in the workplace is conducted on several levels, each hopefully contributing to a learning environment that is non-threatening and success oriented. Using questionnaires, we first of all determine how learners are reacting to the classes. Do they like the class? Do they feel they are learning? Are the materials and methods helpful and appropriate? How well is the instructor doing? We do this on an on-going, continual basis. Students are hesitant to give constructive feedback at first. After a while, a good trust level has been established, and learners begin to give feedback that actually helps the teaching/learning process. They mention exercises that were not beneficial. They mention if the instructor talked too fast. They mention they really liked certain discussions. When they see that teaching processes may actually change because of their feedback, they feel more comfortable sharing responsibility for what goes on in class.

At another level, using multiple methods, we assess what is being taught in class. We have used standard pencil and paper tests. We use demonstrations. We keep portfolios of work. To demonstrate that some assessments are used to improve the teaching process at this level, we ask learners to turn in papers anonymously. They make some identifying mark on their papers so they can recognize them later. We use the results to let us know how well we have taught concepts. We look for more than a correct answer in mathematical computations. We also look for correct procedures. Often learners may work in groups to solve problems or assess concepts and/or curriculum. In this way, communication and connections are outcomes that provide a means of assessment as well. At jobsites where workers are not limited in the tools they use to solve problems, calculators, computers and/or manipulatives are used in assessment procedures. If workers are not allowed these tools on the job, the tools are still used in class but more emphasis is placed on solving problems without them.

At still another level, we are concerned about how workplace learning affects the company. Are workers better prepared to do their jobs? Are changes in attitude taking place? In general, what, if anything, at the company is being affected by the program. This level of evaluation may consist of interviews with supervisors or supervisor questionnaires. Workers may meet in focus groups to discuss the effects of class on the workplace. Workers may evaluate their own learning in light of job performance through interviews or questionnaires. There are many ways to generate data at this level.

Confidentiality

Few educators understand the necessity of confidentiality in the workplace. Most will give lip service to the concept without fully realizing its implications. It may be for this issue alone that instructors must begin to understand the politics of individual worksites and how these politics affect the worklife and personal life of workers who come to a workplace education class.

What workers choose to share about their learning and with whom they choose to share it should be their business, not that of the instructor. As we have stated before, workers must learn in the workplace. They generally have no choice. With that understanding, it is the duty of the instructor to bring to bear all that s/he knows about the teaching/learning process to the job site. We know that learning takes place best in a safe, secure environment, in which learners are willing to take risks. Again, stating this strongly: We **know** this to be true. Educators must act on what they know. If workers know they can trust the instructor implicitly with their learning, they will speak and question more freely without fearing that their classroom comments or progress will find their way to a supervisor or personnel file.

Funding

Recent research in the state of Illinois revealed that basic skills training in private sector firms is largely company-based. Other sources of funding have been organized labor, public funds, provider funds or employees paying for some portion of their training. These sources of funds exist in all states. However, workers employed in small to medium sized firms that do not have training departments, training budgets, or access to grant writers can be denied opportunities for training programs due to this financing issue.

In Smart Workers, Smart Work, the Southport Institute for Policy Analysis reported that one of the most important public policies for promoting workplace education programs would be to provide these services at reduced, or even no, cost.

What to fund. Whatever the source of funds, money should be available for administration, program planning and needs assessments, curriculum design, instruction, and evaluation components of the program. At times, teacher training and/or staff development are necessary components as well. Specifically, this means training on how to use manipulatives and technology correctly. To teach specific work applications of math teachers may need training in such concepts as Statistical Process Control or the International Standards Organization (ISO 9000). Further, funds will need to be spent on appropriate manipulatives and calculators.

How long to fund. The Illinois research further indicated that the most successful programs were those that ran for three years. In its own research, the National Workplace Literacy Grant Program echoed this need for longer term programs and subsequently changed its funding timelines. The current funding cycle reflects the possibility of funding programs for three years--up from 18 months of the past.

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Chapter 7
Proceedings of the 1994 Adult Mathematical Literacy Conference

ADULT BASIC EDUCATION MATH INSTRUCTION -- MASSACHUSETTS PRACTITIONERS' VIEWPOINTS ON THE ABE LEARNER AND THE INSTRUCTIONAL ENVIRONMENT

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Purpose

During 1993, twenty adult education teachers met monthly in four work groups to study, reflect, and adapt their instructional practice based upon a shared reading and discussion of the *Curriculum and Evaluation Standards for School Mathematics* (National Council of Teachers of Mathematics, 1989) and its applicability to ABE teaching. As a starting point for their reflection, each group was asked to describe their learners and the environments in which they taught. This paper, adapted from *The ABE Math Standards Project, Volume I, The Massachusetts Adult Basic Education Math Standards* (Mass. ABE Math Team, 1994) summarizes their findings and raises some issues and implications for classroom teaching as seen by a group of adult education practitioners interested in the reform of adult basic mathematics instruction. (See Chapter 11 for a description of their final product.)

The Adult Basic Education Mathematics Learner

The ABE Math Team work groups defined themselves as instructors of four seemingly diverse adult populations : (1) ABE/literacy learners, (2) English as a Second Language (ESL) learners, (3) Adult Secondary Education(ASE)/GED students, and (4) Workplace Education participants. However, when the authors of this paper sorted out the learner profile data gleaned from each of the work groups, we saw that among and between these groups certain characteristics are shared by all the learners which have a definite impact on how they learn math and what math they need to learn. These characteristics contain implications for any curriculum planning and methodology inherent in fashioning a new vision for mathematics instruction in adult basic education.

Across groups, all adult learners are goal-centered. That is, they want to be able to survive better in society: they want a second chance at a high school diploma, to get off welfare, to get a job, to get a better job, to help their kids or just improve themselves. They are from all age groups, but with most being represented in the workforce entry-and-exit age range of 18-60. Some, especially in the case of workplace education, already have high school diplomas, but feel the skills they learned (or had trouble learning) as much as a generation ago no longer serve them in the jobs they hold today.

The vastly diverse ESL population frequently has learners who hold advanced degrees in their country of origin. Others come from countries where access to basic skills learning is marginal or totally absent. Young, native born Americans who did not complete high school are taking classes because they quickly discovered the limitations of trying to succeed with too little education. Some learners in adult basic education classes often enter programs with the hope that a GED diploma will be quickly earned, even though their entry level skills, as measure on standardized tests (such as the TABE, Test of Adult Basic Education) are below the middle school level. Above all, these goals center on the world of "now," unlike the more future-oriented, child-centered world K-12 instruction. While these personal goals are shared by most basic education students, they are not the only factors which influence the math learner's desire to perform.

Much of the math instruction that takes place in the adult basic education environment is defined by societal benchmarks. Programs are driven by outside requirements: success is determined not by such standards/goals as those detailed in the NCTM vision, but the the number of GED diplomas awarded, increases in grade level achievement, or total job placements. Public Assistance recipients are increasingly required by federal and state governments to attend basic skills classes. In the midst of such pressure, it can be difficult to teach math in the spirit of cooperation, where various learning rates and styles are acknowledge, and where the "right" answer is not always the one at the back of the book or on the test.

Beyond such formalized external pressures lie the additional concerns and conflicts adults at any educational level face every day. Child care issues, health problems, transportation needs, housing concerns and economic instability can be daunting hurdles which frequently bar the way to the learner's achievement of educational goals. In an average adult basic education class there may be students who cannot physically or mentally attend to learning because the medication they are given impairs their performance, or because they have just come from working two full-time jobs back-to-back. Others come to class from extremely dysfunctional family situations, while some are homeless.

Adult learners who participate in ABE math, GED math, or basic skills classes attend on average from one to three hours per week. The number of weeks of instruction varies from site to site. Skill levels range from beginners with almost no math education (or sometimes any education), to college graduates from other countries. Class sizes are small in comparison to public school standards --- ten to fifteen students. However, the wide range of abilities often found in a single class provides a true challenge for the adult basic education instructor. In most settings, attendance is voluntary, although attendance rules are set by the learning provider and vary from program to program. Absenteeism, related to many of the problems listed above, impacts the rate at which a student learns, the consistency of the group, and the planning and preparation efforts of teachers. Instruction is usually, but not always, individualized, or is conducted in small groups. Use of published "adult education" math workbooks is frequently the norm, but some teachers prepare their own and supplemental materials. Most of the published materials currently available focus on computation problems. In addition, these materials assume a level of reading ability on the part of the learner that is often too high and seriously limit students' access to math learning. Some teachers make or buy math manipulatives; very few teachers have access to one or more computers. Use of calculators varies from site to site. Often math education is considered an "add-on" to basic skills instruction in reading and writing. Some programs use the reading score form a standardized test to assess readiness for math instruction, while most use a more specific math skills assessment for placement.

Four Instructional Environments

While adult basic mathematics learners have a lot in common, they also have many differences: the setting where they receive instruction, the functional abilities and life experience they bring to the class, and their personal vision of what the class should be. These students usually find themselves, or are placed, in one of four instructional environments.

1. The ABE/Literacy Mathematics Classroom

The ABE learner is usually an English-speaking individual whose reading level ranges from literacy level to pre-high school level, but whose math ability can range anywhere from pre-computation skills to secondary level math. In the last few years there has been an increase in the number of English as a Second Language individuals in the ABE math class, who may or may not have been schooled in math in their native countries, but whose reading level in English places them in the ABE level class. Among English-speaking native students, most of these learners have not completed high school; some may have learning disabilities. For many, there is a high dependence on auditory or tactile learning because of low-level reading abilities. Some are concrete learners who have underdeveloped abilities in abstract reasoning. ABE learners may be self-confident or have low self-esteem. Their educational goals (to pass the GED test in a relatively short time, for instance), may or may not be in line with their incoming basic skills level. At the same time, learners in this group (like nearly all adult basic education learners) bring a wealth of motivation and courage to the task of learning math. Such determination makes teaching the adult basic education student a continuing pleasure.

Settings for ABE programs vary: church basements, libraries, community organizations, public schools, college classrooms, etc. Sometimes math instruction is a one day per week affair incorporated intro reading and writing instruction, sometimes it may be a separate class by itself and meet several times a week.

2. The English as a Second Language Mathematics Classroom

The ESL math learner population falls into three groups:

a) non-native English speakers enrolled in ABE/pre-GED/GED classes who can communicate effectively in oral English and may be integrated into ABE classes with native speakers;

b) students in informal ESL classes and basic skills classes where they may be learning every day survival math but are not enrolled in a formal math class;

c) students enrolled in native language literacy and basic language classes where math, if taught, is done so in the native language. This group also includes learners who are preparing for the GED in Spanish or French.

Instruction for all these groups is framed by specific expectations of both the learning provider and the learners themselves. While everyone would agree that math learning is the "third basic" for any non-native ABE participant, it is often the last essential to be addressed, given the learner's language limitations. Unless classes are bilingual, direct instruction in mathematics for the ESL learner is usually postponed until the oral/aural language skills are developed. Unfortunately, as ESL learners begin to gain access to the institutions and social settings of the English speaker, real life math-related situations arise which the individual is unable to verbally address--- he/she does not know or cannot use the "language of math."

Often culture-based math learning experiences determine the way ESL learners expect to approach math as adults. A preconceived image of "teacher-as-expert," the gate-keeper of knowledge, may inhibit the ESL math learner's willingness to use inherent intuitive insights or to apply life experiences and common sense to problem solving situations.

Rote learning, text-specific math experiences are often what the ESL math learner seems to need or want, based on his/her own education experiences, and any instruction such as group work or examination of multiple approaches to solving the same problem might be suspect. (It should be noted that this phenomenon is not isolated to only the ESL math learner; many English-speaking native students have experienced the same type of "teacher-centered" math instruction.)

3. The Adult Secondary Education/GED Mathematics Classroom

ASE/GED learners include individuals in GED preparation classes or adult education programs called "Adult Diploma Programs" or "External Diploma Programs," which grant an alternative competency-based, high school credential. Passing the GED or the ADP/EDP math competency test is the primary goal of this math student. The objectives of developing a problem solving attitude, being able to communicate in mathematical terms, reasoning mathematically or seeing mathematical connections in every day life are, for this learner, often secondary at best. Ironically, standardized tests and employers as well are now requiring the very problem-solving strategies adult diploma candidates don't view as important.

At any rate, most ASE/GED learners enter the adult diploma class resolving to buckle down, pay attention and succeed this time; to undo unsuccessful past educational experiences; or sometimes to fill in the learning gap between schooling received many years ago and the survival demands of today's world. This new-found resolve can be tenuous and may be tested by life situations which often seem insurmountable: child care problems, racial discrimination, poverty, loss of employment, health problems, imprisonment, and others. The learner's resolve to "play-by -the-rules," and pass the test may be fragile. In the face of these obstacles, it is a continuing challenge for all ASE/GED instructors to offer learners substantive math skills that will serve for a lifetime.

4. The Workplace Education Mathematics Classroom

In some ways, the math learner in a workplace environment has distinct advantages in contrast to many learners in community-based settings. First, of course, he/she has a job, which can have enormous implications for the learner's self-esteem and belief in his/her ability to learn. Second, the company (frequently in tandem with the employee union) provides and supports this on-site education — the learner does not need to travel to take advantage of basic skills training. There is often pay linked to attendance in such classes. And finally, workplace students have the chance to immediately apply what they have learned by practicing newly formed skills back on the job. With all these advantages, however, the workplace environment also carries with it implicit messages to learners which can be worrisome or even frightening. Students/employees can see the writing on the wall: the skills they have currently many not be enough to help them keep their job in the near or distant future. Many workers have held the same or similar jobs for years or even decades; they see their company moving into the age of high technology and are fearful of being left behind. Often the skills they received via middle school, high school, or in some cases post-secondary education do not help them feel competent when it comes to doing statistical process control charts, or checking tolerances to three decimal places. They are embarrassed when faced with these situations; they are equally as dismayed when supervisors suggest they upgrade their skills.

Workplace math learners come from all functional education levels: some can't read or perform the four basic math operations, others don't speak or read English well, some never got the high school diploma and want to get a GED. But all need to be able to do the math related to their jobs with more accuracy and facility. Learning providers respond to this by examining closely the daily math tasks required on-the-job. Math materials are either purchased or created which directly address these requirements. Because workplace priorities frequently come before classroom priorities, attendance can sometimes be a problem. This, and the broad range of abilities stated earlier, prompts many instructors to work individually or in small groups with workplace learners. Class schedules are formed around the work schedule, and math programs can be victims of the same vicissitudes a company can face: downturns in the economy and loss of company profits can signal the end for job-related math classes.

Summary

Although the Massachusetts ABE Math team considered the learner profiles, classroom description, and teaching practices of four often distinct adult instructional groups, there were many common attributes found among the ABE, ESL, GED, and Workplace education environments. These included: the range of basic literacy and mathematical skills and academic backgrounds of the adult learners; the presence of and instructional needs for math instruction of non-English speaking or limited-English proficiency students; the external and programmatic pressures placed on learners and instructors by funders, outside social service agencies, workplace employers; the economic, social, family, and time pressures on adult learners; the lack of published instructional materials which meet the multiplicity of adult learning styles and cultural/linguistic diversity of adult learners. Each work group also described the distinct instructional needs dependent on the goals of the learners, the mathematical content or skills levels, and standardized testing requirements in the particular learning environments. This consideration of "where we are now" --- who we are teaching, where our teaching takes place, how and why we teach what we teach, what affects our classroom, what materials we use, how we use technology --- was a necessary precursor to considering the reforms suggested by the NCTM *Standards* and their applicability to teaching adult math learners.

Implications for Reform

Context:

* How do the different stakeholders of adult education view the context of the current delivery system ---
    * Who are the adult math learners?
    * What math do they need to know? to learn?
    * How do they learn math best?
    * Who are the adult education math teachers? What preparation do they need to teach adults mathematics literacy?
    * What curriculum and teaching methodologies best meet the needs of a diverse group of adult math learners?

Equity Issues:

* Who should receive adult education math instruction?
* What about math instruction for ESL (non-English speaking or limited English proficiency) students? How should math instruction be offered in native language literacy classes?

Teaching:

* How can practitioners deal effectively with the range of mathematical and reading levels of learners in their classrooms, including adults with learning disabilities? with the various learning styles of adult learners? with the language needs of ESL learners in the ABE math classroom?
* What staff in-service training or staff development activities are needed to help practitioners address these issues?

Technology:

* What is the role of technology in the ABE math classroom?
* Should instruction in using appropriate technology (including calculators and computers) be included in ABE/GED math instruction? What about calculators?

Tests:

* How much is instruction in adult education determined or influenced by standardized testing? How is this helpful? How is this a hindrance?

Texts:

* What instructional materials are needed —
  (a) to address the multiple learning styles of adults?
  (b) to address the math content that adults need to know?
* Who will develop instructional materials which will go beyond teaching computational skills or routine problems?

Chapter 8

Proceedings of the 1994 Adult Mathematical Literacy Conference

EXPLORING WHAT COUNTS:
A Summary Report of Research into ABE Math in Massachusetts

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"Math is a system of numbers made up for the human race to be able to solve problems and go on with life."

- Julio and Jake, Math Learners
County House of Corrections

Purpose

This paper provides a summary of selected findings from a recently completed study that explored how mathematics is taught in Adult Basic Education (ABE) programs throughout Massachusetts.

Introduction to the Study

The Research into Adult Basic Education Mathematics (RABEM) Project was funded by the US Department of Education through the Office of Educational Research and Improvement as a Field-Initiated Study grant to World Education. World Education serves as the Central Resource Center for the System of Adult Basic Education Support (SABES), the state's literacy resource center.

The RABEM study was conducted in two phases. In the first phase of the study, survey questionnaires were sent to all ABE program administrators and, through them, to the entire population of ABE instructors responsible for teaching math. The data from these questionnaires was reviewed for thematic patterns used to identify criteria for selection of a case study sample for the second phase of the study. The survey sample included 77 administrators (out of a population of 320) and 141 instructors (out of a population of 1130). During the second phase of the research, in-depth interviews with 17 instructors and 49 learners were conducted, and observations took place in 15 classrooms.

An analysis of this data has produced a detailed picture of ABE math programs, instructors, learners, instructional approaches, teaching materials, and assessment tools. Insights from this study continue to inform program and staff development efforts now underway to improve the way math is taught in ABE classes in Massachusetts. Detailed below are findings which help to describe the broad context of the delivery support system for ABE mathematics that exists within one state.

Adult Basic Education (ABE) programs offer many different types of classes defined by the needs of the adult population addressed or the curriculum and content covered in classes. Adult Basic Education is an umbrella term used in Massachusetts to describe all programs that address educational needs of adults below a college or technical training level. It is refers to the same population targeted by terms such as adult mathematical literacy or numeracy.

The Adult Math Learner

> Sharon is 32 years old and a life-long resident of Massachusetts. She came to this adult education program 6 1/2 months ago because she wanted to improve her ability to deal with the demands of her daily life. She wants to set a good example for her kids and feel better about herself. She hopes to get off welfare because she doesn't believe that relying on that check is the right way for a family to live. She last took math in 1980 when she was in 10th grade, and she hated math then because it was frustrating and made her feel stupid. Math seems OK now, and she is not as afraid of it as she used to be. She is now able to help her kids with their math homework. It's only the confusing word problems that trip her up these days.

Sharon is not an 'average' learner. She is one of several composite learners created to share and situate the data collected. The learners in this study were rich in diversity, ranging from a 16 year old Hispanic teen mother to a 70 year old veteran of World War II. Our sample indicates that learners in math classes across Massachusetts are most likely to be women (69%) and between the ages of 25 and 34 (41%). A majority of learners interviewed were born in the US (63%) and have English as their first language (65%), followed by Spanish (14%), French (12%), and a wide variety of other languages. The majority of ABE math learners (63%) had been out of school for more than 10 years. For most adult learners, reentering a math classroom is a decision that has not been made lightly. About half of the adult learners interviewed in this study dropped out of school between the 7th and 10th grade. Twenty-four percent made it all the way to 12th grade or completed high school, while 16% never made it past 6th grade.

The range of learner background and experience is a major challenge to ABE math instructors. As most programs are small, multi-level classes are common. This makes it difficult to meet each learner's needs while maintaining class cohesion. With broad range of ages and learning experiences within the class, instructors find that the math 'language' and terminology is often different. Many instructors must work with learners who need help with basic computation skills while teaching algebra, geometry, or advanced mathematics to others. And for each learner, they must consider how math was previously learned.

Few adult learners begin a math class with enthusiasm or pleasant memories, but most learn to enjoy, or at least feel comfortable with, math. While over 50% of learners surveyed disliked math when they were children, not one felt fear of, intimidation by, or dislike for math once they had experienced learning math as an adult. This does not mean that everyone now enjoys math, but many expressed pride in how much they were learning compared to their previous experience in school. Table 1 presents data on how learner attitudes have changed about math.

Learners enter a math class with the goal of achieving a GED, improving their job opportunities, getting off welfare, or qualifying for skill training. Once in a math class, learners are motivated by the usefulness of the math they are learning. Math instruction must build on this motivation by employing approaches that are grounded in the real life of the learners and address problems that they see in that life. They are adults with a rich experience and a capacity to participate as active decision makers in their learning. Any movement to reform math must involve them as full partners.

Table 1: Learner Feelings About Math

Position/Feeling	Then $n=46$	Now $n=48$
Enjoyed math/Like math	24%	31%
It's OK	-	10%
Began to enjoy it as skills improve	7%	13%
Liked some parts, disliked others	7%	8%
Disliked/hated it	30%	-
Felt stupid/intimidated by it; feared/avoided it; frustrated/confused by it;	22%	-
Did not notice/care about it /think it was important	7%	-
Was scared to be wrong	2%	-
Can't remember	2%	-
Learning a lot (more math in 3 months than all previous schooling/improved GED score/prepared for colle[illegible]	-	17%
Very motivated	-	8%
It's important to know/useful	-	4%
Sometimes its frustrating/hard	-	4%
It's challenging	-	2%
Realize how much math I already know	-	2%

For many learners, the definition of math is simple: *"Math is life"* or *"Math is everything."* Learners keep it simple, but they do identify the importance and relevance of math with statements such as: *"Math to me is: if you don't learn math, you don't know nothing... because in the US, mostly everything is with numbers."*

The ABE Math Instructor

Terry is 41 years old and has been teaching part-time at an ABE Program for a little over 4 years. She teaches a GED class and math is part of the program package. Before coming to this program, she taught 3rd grade for 3 years and tutored a few young adults in basic math. She never really liked math, and although her grades were satisfactory, it was not her best subject. The last math she studied was in High School, where she took Algebra and Geometry. While Terry still doesn't enjoy math all that much herself, she truly enjoys making learning math a good experience for her learners and helping them to overcome their fears and gain confidence.

Fully 83% of instructors are part-time or volunteer instructors, and 74% of ABE math instructors are responsible for teaching other subjects as well. Only 10% of all math instructors teach math alone, and these account for approximately 2% of all ABE instructors in the state. Nearly half of the programs (49%) that offer math have no full time instructors responsible for teaching math.

Thirty-six percent of ABE math instructors have had no previous experience teaching math. Of those who have taught before, almost all have taught math within the formal school system at one time or another (K-12 levels). Only 14% have direct experience teaching math in ABE settings prior to their present position. However, 55% have taught 19-22 year olds and 49% have experience instructing learners over the age of 22. For 18% of the ABE math instructors working in programs, the last mathematics they had was in High School, and for most of them this was over 20 years ago.

Thirty-six percent have received no additional training related to math since beginning their work, and 55% received no training in the past year. Only 11% of ABE math instructors are members of organizations, professional associations, or informal groups that focus on mathematics. Instructors are evenly split between those who have an interest or experience in teaching math and those who have had it thrust upon them, chance and trial and error becoming their personal tutors in how to approach math instruction with adults.

About 70% of instructors did poorly in math or struggled with it when they were in school. Many have vivid memories of when and why their math learning went sour. They are most troubled by memorization, the complexities of math and word problems, trick questions and by their feeling of incompetence and lack of math knowledge or experience.

ABE math instructors are not unlike their learners in attitudes towards math and the long time away from formal math study. Instructors share opinions about teaching math with learners as well when they point out that adult learners deserve math that is relevant to their daily lives and that has a focus on problem-solving skills rather than computation. As one instructor put it in discussing the need to change the computation-based approach to instruction, "Math is too important to be treated without creativity". Reform efforts must accept that ABE math teachers have not been chosen for their content knowledge, experience or training, and that they have been given very little training.

The ABE Math Program

ABE programs offer courses covering a wide variety of contexts including programs for adults with low level literacy and numeracy skills (ABE/AEE)[1], and programs focused on Adult Secondary Education (ASE and Pre-ASE), English for Speakers of Other Languages (ESOL/ESL), workplace education and family literacy classes.

Most programs offer many different types of classes. Regardless of the class type, mathematics instruction seldom happens alone. While classes devoted to reading and language instruction exist, mathematics is generally one of several topics being taught in a class. As learners move from ABE to pre-ASE to ASE classrooms, there is a greater likelihood that they will spend increasing amounts of time on math as a component of a multi-subject curriculum. ESOL maintains its focus on language and communication and seldom focuses on math beyond minimal survival skills. Mathematics instruction is a

[1] *Adult Basic Education (ABE) serves as both umbrella term and marker term for this population. Alternately, the use of Adult Elementary Education (AEE) is being explored.*

Table 2: Instructional Focus by Level

Instructional Level	Focus: Reading and/or Language Instruction		Focus: Reading and Math Instruction		Focus: Math Instruction (only)	
ABE (0 - 4)	14	18%	37	48%	1	1%
Pre-ASE (5 - 8)	26	17%	47	61%	1	1%
ASE (GED)	8	10%	49	64%	2	3%
ESL: Beginning	39	51%	11	14%	0	0%
Intermediate	38	49%	14	18%	0	0%
Advanced	26	34%	11	14%	1	1%
Workplace Education	4	5%	12	16%	0	0%
Family Literacy	11	14%	2	3%	0	0%

prominent and integrated part of workplace education but is seldom seen in family literacy classrooms.

Massachusetts provides ABE through a number of different types of institutions, including Community-Based Organizations (CBO), Local Education Authorities (LEA), Community Colleges, Libraries, worksites,and Correctional Institutions. Any reform movement must operate within this wide variety of institutions and serve the many kinds of classes.

How is ABE Math Taught?

The majority of programs and instructors report classes that are a combination of whole class (large group) instruction and individual instruction within class. As illustrated in Table 3, program administrators report that most of these learners receive individual instruction (33%) within a class context. This is followed closely by full class instruction (29%) and small group instruction within a class setting (14%). Ten percent of the learners receive individual tutoring, 5% participate in computer assisted learning and 3% are in small group tutoring. The remaining 1% of learners receive their math instruction in drop in classes.

The majority of instructors (47%) and learners (35%) report that they spend between 1 and 3 hours per week on math. About half as many instructors (29%) report that they spend between 3 and 5 hours per week on math. While 12% of the instructors reported up to 9 hours per week of math, a few learners recorded as many as 12-15 hours spent each week on math. According to instructors, how much time is spent on math instruction may be decided by instructors (41%), program directors (35%), learners (24%), grant, contract or financial considerations (18%) or instructor/learner discussions (18%). For many programs, a variety of individuals and factors are involved in the decision. From the learner's perspective, however, the basic amount of time spent on math is sufficient (58%), although 38% consider the amount of time too small. For those who believe that math deserves more time, their suggestions run on average towards the 3-5 hour per week mark.

Table 3: Instructional Formats for Math

Responses	Program *n=55*	Instructor *n=141*
Class instruction (whole class)	73%	61%
Small group instruction (within class)	58%	52%
Individual instruction (within class)	73%	66%
Drop in classes	20%	8%
Computer assisted learning	38%	24%
Individual tutoring	73%	50%
Small group tutoring	35%	21%
Other	4%	2%

Program administrators identify the greatest amount of time spent on math by learners involved in drop-in classes (2.8 hours on average), although this also includes the widest standard deviation in responses (+/- 9.8) and a range of 0 to 24 hours per week reported. This coincides with what one might expect from a drop-in structure where the learners themselves determine the amount of time to be spent on learning math. The next highest times are spent by classes involved in full class instruction (2.4 hours), individual instruction in class (1.8) and individual tutoring (1.6). The least amount of time is spent on small group tutoring (.6), computer-assisted learning (.9) and small group instruction within a class (1.3).

Program administrators and instructors both report a wide range of curriculum types and sources as well as mechanisms for curriculum development. As ? reflects, individual instructors have the greatest say in curriculum decisions. Program administrators at 60% are, in general, more convinced of this than many of the instructors (41%) themselves. Program administrators tend to paint a picture of diverse decision making mechanisms for math curriculum. In general, influences on math curriculum seem to include: the personality of the current instructor, the instructional legacies of previous instructors, the recommendations for curricular structure provided by the program, and the texts and materials available.

ABE math classes use a wide variety of materials. Almost all (86%) however, utilize at least one (and usually several) published math texts or workbooks. Although influential, these texts seldom drive the entire curriculum. They are usually supplemented with other support materials. In about 70% of ABE classes, instructor developed materials are in use. While program administrators (46%) mention manipulatives more than instructors (32%) report their use, direct observation of classrooms found math manipulatives evident no more than a third of the ABE math classrooms.

About 35% of ABE math classes have computers, although the degree to which they are actually used to support math is questionable. Among the 15 programs visited, 6 had computers of some sort in their classrooms with most having between 1 and 3 available for use by 10 to 36 learners. Most computers were not used for math instruction (whether math programs were available or not) but were available on occasion for learners to practice writing and learn word processing. Other programs have computers that are not or are so old that instructors question their potential usefulness.

Calculators were not only mentioned as present by about 30% of program administrators and instructors, but were seen in about as many classrooms, both accessible and in use. Where calculators were not available to learners, a number of instructors expressed a specific desire to have them on hand but had been unable to convince others of their importance nor devise a way to keep such an accessible and mobile item in the classroom once they got them. While there is still a basic distrust of calculators among instructors and learners, some are starting to recognize just how available calculator's are in everyday life. Once instructors and learners realize how calculators can free learners from the drudgery of computation, the instructional focus shifts towards opportunities to explore problems in greater depth.

Table 4 shows data related to how effective a particular material might be in the support of math learning. First, instructors' use of each material is reported again to provide a relative gauge for how often these materials are used in an ABE math class. Next, instructor opinions of how useful they find various materials in helping learners grasp math are shown. This is followed by learner views of what math materials are used in their classroom and which of these materials they like best.[2]

From this analysis, the most effective materials for learning math are manipulatives. While only

Table 4: Effectiveness of Support Materials

Type of Material	Instructor *n=141* Used	Instructor *n=141* Effective	Learner *n=49* Used	Learner *n=49* Effective
Manipulatives	32%	28%	39%	80%
Published Materials (texts/workbooks/worksheets)	86%	36%	47%	10%
Teacher Developed	70%	28%	4%	0%
Calculators	30%	11%	39%	4%
Computer Programs	35%	15%	12%	2%
Learner Generated	16%	11%	4%	0%
Games	29%	6%	4%	2%
Charts and Graphs	11%	3%	0%	0%
Any materials that fit student needs	-	7%		
Materials that relate to daily life	-	4%		
Audio/Videos	-	4%		
Blackboards	-	-	8%	2%

[2] *Learners do not necessarily recognise the source of materials (text, instructor, etc.). Their responses for what is used indicated rather what they remember from their classes and they link materials closely to specific math topics. Remembering a material was considered an indicator of how well a topic was learned and thus how effective the material was.*

39% of learners mentioned them as one of the "different things" (objects, workbooks, materials) that their instructor used to help them learn math, 80% of the learners interviewed identified manipulatives as the material "they liked the best". Instructors identify manipulatives as one of the most effective suppo t materials for assisting in math learning.

How are Learners Assessed and Placed?

Learners math ability and initial placement within a program are usually based on intake assessments, the majority of which (84%) are done with standardized tools. Only 10% of programs use program developed assessment instruments for conducting learner intake and placement. About half (53%) of the programs use the TABE (Test of Adult Basic Education) as their primary intake assessment instrument. Other standardized assessments used by programs include GED Practice Tests, CASAS (Comprehensive Adult Student Assessment System), and WRAT/WRAT2 (Wide Range Achievement Test). In general, however, most programs and instructors use a variety of mechanisms for assessing learner math abilities and determining placement. Programs have control over learner intake and assessment and pay attention to learner's interests and goals, self reported ability and oral English levels. Instructors rely on self-reported abilities, goals and interests and other information shared during interviews with learners. Once a learner is placed, most instructors use assessment instruments of their own to identify specific math skills needed. During interviews in this study, learners were found quite capable of contributing to their The experience of this While portfolio assessment of mathematics was not a prominent feature of any program, there were indications of movements in that direction.

Table 5: Assessing Learner Math Abilities for Placement and Planning

Type	Programs n=55	Instructors n=141
Intake assessments	93%	88%
Learner interest/goals	64%	28%
Self-reported ability	45%	35%
Interview	47%	33%
Reading level	29%	18%
Previous level achieved	24%	19%
ESL level	31%	6%
Class space constraints/ availability of tutors	14%	3%

Implications

The information from the RABEM study as shared above offers insights into many factors influencing math instruction. As part of an ABE reform movement that began in Massachusetts five years ago, it has contributed to a shift in approach. Reform initiatives often are designed at a state or national level and imposed on practitioners. As reform involves change of practitioners attitudes and practice, it is best begun from a solidly grounded base. While program administrators and policy makers have a sense for general trends, it is the adult learners and their instructors who truly know what is happening and what can happen in math instruction. The most important finding from RABEM is the validity of these views. Policy makers should not only realize the important insights that learners and instructors offer, but should identify mechanisms for involving them in the dialogue around instructional reform. Improving ABE service delivery is much more likely to occur when the key players are involved in setting agendas and issues.

In addition, the RABEM study reveals several issues within the current delivery system that deserve particular attention. Adult learners come to ABE math classes with a diverse set of characteristics, experience and needs. Most learning environments for math are multi-level classrooms, where this diversity of educational background and needs creates a challenging environment for instructors. Instructors themselves have minimal training in mathematics or math instruction and few opportunities to gain more. Math is given minimal instructional time. To top all of this off, most learners enter math classes with a high level of anxiety. With all of these barriers in place, learners still manage to shift their attitudes and increase their self esteem in the process. Rather than an 'extra' activity, math may have a better place as an important entry activity as learners can quickly see progress and feel a sense of accomplishment; important factors in helping learners to remain in a program.

Many changes in the way math is taught in ABE programs are both recognized and desired. Instructors and learners left to describe an ideal ABE math learning environment will include many of the elements put forth in the NCTM Standards, their Massachusetts ABE adaptation or the SCANS Report (as described in other articles in these proceedings). Learners respond well to activities that are grounded in their everyday lives and learn best when the materials and methods are realistic and concrete. Instructors need opportunities to share experiences with colleagues and develop expertise in facilitating active, collaborative learning activities if they are to meet the needs of their math learners. As a critical and necessary skill, math instruction deserves and requires more time. Assessment mechanisms currently in use serve only to assist in placement and justification of funding. Learners are capable of participating in their assessment and evaluation and should be more actively involved in this process. Policy makers should take note of these points and remember that, if *effective* reform of math instruction in ABE environments is the end goal, instructors and learners must be seen as critical participants in a long term process.

A complete version of the RABEM project report ("Exploring What Counts: Mathematics Instruction in Adult Basic Education") can be obtained by sending $10.00 (payable to World Education) and your request to John Comings, World Education, 210 Lincoln Street, Boston, MA 02111.

Chapter 9
Proceedings of the 1994 Adult Mathematical Literacy Conference

NCTM AND CHANGE IN MATHEMATICS EDUCATION

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Purpose

The National Council of Teachers of Mathematics (NCTM) began in 1920 as an organization of individuals interested in the teaching of mathematics. Originally, the organization was focused on the teaching of junior and senior high school mathematics but, over the years, began to include elementary school, college, and to some extent adult mathematics educators as well. In this chapter, I discuss the following:

- What is NCTM and what does it do?
- Why is NCTM pushing for change in mathematics teaching?
- What are the NCTM *Standards*?
- Why should adult numeracy educators be sharing ideas with other mathematics teachers?

What is NCTM?

The National Council of Teachers of Mathematics (NCTM) is an organization of over 100,000 members who are involved in the teaching of mathematics at all levels. It currently publishes four journals about mathematics teaching: one for elementary mathematics teaching, one for middle grades mathematics teaching, one for secondary mathematics teaching, and one for research in mathematics education. NCTM also sponsors regional and national conferences on the teaching of mathematics. This year's national meeting takes place in Indianapolis in April and is expected to draw 14,000 mathematics educators. Among the almost 1000 sessions that have been planned will be a number with relevance to adult education. Regional meetings, which take place in October, are planned this year for Boise, Phoenix, Tulsa, Edmonton, and Omaha. Over 200 state and local affiliates of NCTM also have periodic meetings on mathematics instruction.

Mathematics in the 21st Century: What Skills are Really Necessary?

Before looking at the dramatic changes that are taking place in mathematics education, it is important to provide the background for those changes by looking at the mathematics skills that will be needed in the 21st century. Forty years ago, record keepers made a living doing pages and pages of computations. Those individuals needed to be fast and accurate, but how many people must do computations with paper and pencil for their jobs today? As most adult educators are aware, the numbers of individuals who need to do traditional paper and pencil computations in their jobs or at home is very small and decreasing. To take a simplistic example, what mathematics skills are needed to work in a fast food restaurant? Workers do not use paper and pencil computational skills. Rather, they must use classification skills to make sure that each type of hamburger is placed in the correct bin. They must use communication skills to decide who will make the french fries and how many batches will need to be made. They must use estimation skills to determine, from the size of the line at the counter and the normal amounts of business at different hours of the day, how many of each type of hamburger to make. In addition, they need to make common sense decisions about what task should be attended to next.

Compare the mathematical skills required to work in a restaurant to the traditional middle school, high school, and adult education mathematics curricula. How often do we expect classroom learners to make an estimate based on continually changing data? How often do we allow classroom learners to discuss a problem with others before trying to come up with a solution? How often do we expect classroom learners to combine experience and common sense to answer a mathematics problem? Unfortunately, few learners in traditional classes have had much experience with these kinds of activities. Why is the gap between school mathematics and workplace mathematics so great?

One explanation for the gap between school and workplace mathematics is tradition. The curriculum has always been focused on computation, so that is what is expected in mathematics classrooms. There has also been the argument that students must learn the "basics" before they can be expected to master higher-order skills such as estimation. There is some truth to this notion: an individual must have an understanding of addition and multiplication to make a reasonable estimate of the amount of food that should be prepared to meet the needs of customers standing in line at a fast food restaurant. On the other hand, individuals with limited computational skills are certainly capable of using common sense and coming up with creative ways of solving "real life" problems. Far too often in our society, learners at all levels have been deprived of the opportunity to learn to solve problems because they have not mastered basic computational skills. Evidence from the National Assessment of Educational Progress (NAEP) indicates that many public school students only master basic skills when they practice those skills by applying them to solve more complex problems in later grades (Dossey, Mullis, Lindquist, & Chambers, 1988). The situation is the same for adult learners. That is, the best way for them to learn basic skills is by applying them to realistic problems. Such problems also help learners acquire the divergent thinking skills that are so necessary in the workplace.

NCTM and the Push for Change

The notion that mathematics instruction needs to change to meet the needs of individuals during the 21st century is hardly new. Although a number of reports came out in the early 1980s, three prompted particular attention. *A Nation at Risk* (National Commission on Excellence, 1983), *Educating Americans for the 21st Century* (National Science Board, 1983), and *New Goals for Mathematical Sciences Education* (Conference Board of the Mathematical Sciences, 1983) all focused on the fact that calculators and computers were making the need for paper-and-pencil computational skills obsolete and that more focus was needed on teaching higher-order thinking skills. Unfortunately, there was no real consensus on how to accomplish this aim. More importantly, these early calls for change were coming from organizations whose members were not directly involved in mathematics instruction. Members of the NCTM, as professionals dedicated to the teaching of mathematics, felt that they should be involved in decisions on how to reform mathematics teaching in the United States.

Three documents published by the NCTM provide the framework for its recommendations for change and speak to the needs of both traditional and non-traditional learners. The first, titled *Curriculum and Evaluation Standards for School Mathematics* and often referred to simply as the *Curriculum Standards* (NCTM, 1989), outlines the mathematics content students should be expected to master. The second, titled *Professional Standards for Teaching Mathematics*, or just *Teaching Standards* (NCTM, 1991), provides examples of the types of classroom environments and instruction that make it possible for students to master the content outlined in the *Curriculum Standards*. The third, now available in draft form, is titled *Assessment Standards for School Mathematics* (NCTM, 1993) and focuses on the importance of integrating assessment and instruction throughout the mathematics curriculum. Each document represents over two years of work by literally hundreds of NCTM members. The documents also form the basis for the *ABE Mathematics Standards Project* which looked at how the NCTM standards should be modified for use in adult education settings (see Chapter 11).

What Should be the Focus of Numeracy Programs?

Although the push for change in mathematics instruction has been accelerated by national reports and public sentiment, it is also the result of instructors asking themselves how they can most help their students. Think of the individuals you teach. Can they tell you how the ideas they are learning apply to home or job situations? Do they see that logic and geometry are mathematical skills with everyday application? Do they routinely estimate to make sure the answers they are getting are reasonable? Do they see mathematics as just a set of rules to be mechanistically applied, or as a collection of general techniques and ideas that can be pieced together as needed to solve complex home and workplace problems?

Traditional mathematics instruction has focused too much on drilling students to remember bits and pieces of computational routines. Teachers in seventh grade think students learned nothing in sixth grade. Teachers in eighth grade think students learned nothing in seventh grade. Need I ask what adult education teachers think students learned in school? Teachers cover material in classes but students do not remember it from week to week, much less from year to year.

Educators are finally coming to the realization that traditional instruction has not worked for many students and something else needs to be done. They realize that the skills learned from traditional instruction are only a subset of the ones needed on the job -- even jobs as straightforward as working in a fast food restaurant. In short, teachers themselves know that mathematics instruction needs to change. It is this feeling, as much or more than national reports, that has caused teachers in NCTM to push for change. In the following pages, I outline what members of NCTM recommend to make mathematics instruction better on the assumptions that (a) numeracy instructors will find many of NCTM's suggestions useful, and (b) more communication between instructors in K-12 programs and numeracy programs can only strengthen the quality of both.

The NCTM Curriculum Standards

The *Curriculum Standards* outline mathematics content that students should master at three grade ranges: K-4, 5-8, and 9-12. Four standards are evident across the entire curriculum and form the core of the NCTM recommendations. These standards are:

- *Problem Solving*: The first of the four general NCTM standards involves "mathematics as problem solving." Specifically, when students finish high school they should be able to "(a) use, with increasing confidence, problem-solving approaches to investigate and understand mathematical content, (b) apply integrated mathematical problem-solving strategies to solve problems from within and outside mathematics, (c) recognize and formulate problems from situations within and outside mathematics, and (d) apply the process of mathematical modeling to real-world problem situations" (NCTM, 1989, p. 137). What does all this mean? In short, it means that an individual is not mathematically literate unless she or he is able to think through and solve mathematics problems that are far more complex than the typical word problems in mathematics textbooks. Although the NCTM focus on being a problem solver sounds ambitious, the writers of the *Curriculum Standards* felt that this goal can and must be met by *all* high school graduates. Obviously, being able to solve complex, real world problems is important for adult learners as well.
- *Communication*: The second of the four K-12 standards outlined by NCTM involves mathematics as communication. Students, at all levels, are expected to express the thinking they use to solve a problem both verbally and in writing. Similarly, they are expected to understand and respond to the solution methods described by their peers.
- *Mathematics as Reasoning*. The third standard, mathematics as reasoning, involves having students make and test conjectures, formulate counterexamples, and construct and follow logical arguments. In other words, learners need to be able to decide when mathematics is needed to solve a problem and then keep trying different ways of solving the problem until a reasonable solution is found.
- *Mathematical Connections*. The fourth K-12 standard involves mathematical connections. To really know and be able to apply mathematical reasoning, students must see connections between various mathematical ideas (e.g., adding a negative number gives the same result as subtracting that number when it is positive) and between in-school and out-of-school

mathematics. To put this another way, learners who fail to see how the mathematics they are learning can be applied to solve problems are not likely to remember or use what they have learned. Much of the reason students have forgotten the mathematics they were taught in school is that they did not see connections between the rules they were learning, rules they had already learned, and the situations in which those rules could be applied.

- *Additional Standards*. Other standards for mathematics learning vary by grade level but involve topics such as understanding place value, measurement, various types of estimation, geometric reasoning, algebra, statistics, and trigonometry. These standards speak to specific mathematical content and clearly indicate that the basic arithmetic and algebra skills which comprise much of the traditional mathematics curriculum are only one part of what mathematically literate individuals must know.

In the five years that the NCTM *Curriculum Standards* have been out, it is important to note that they have made a major impact throughout the United States and Canada. Almost all mathematics textbooks published since 1990 include references to the *Standards* and have activities designed to meet them. A survey by the Public Agenda Foundation in early 1993 found that 96% of mathematics teachers and about half of all school principals in the United States were "well aware" of the *Standards* (Public Agenda Foundation, 1993, p. 17). Recent news reports indicating that few students are meeting national goals in mathematics are based on expectations set out in the *Standards*. In short, the NCTM *Standards* have become the guiding document in K-12 mathematics education reform and, with the release of the parallel ABE *Standards* (see Chapter 11) will an increasing impact mathematics curricula for numeracy programs.

The NCTM Teaching Standards

The NCTM *Teaching Standards* (1991) were written as a guide to what instructors should do to assure that students master the mathematics content outlined in the *Curriculum Standards*. Themes of the *Teaching Standards* include:

- *Worthwhile Mathematical Tasks*. Although some computational exercises are appropriate, NCTM recommends that learners explore a variety of more open-ended problems, particularly those that involve *application* of mathematical ideas.
- *Discourse*. Another theme involves discourse, which is defined as mathematical discussion between the teacher and students, and, just as important, among students. Workers who cannot share their mathematical ideas with others do not work well in teams and thus are limited in the sorts of jobs for which they qualify.
- *Tools*. NCTM recommends using a variety of "tools" to enhance discourse/discussion in mathematics. Tools can be calculators and computers, but they can also be simple things such as drawings or charts that help others to understand a problem and its solution. For adult learners, tools include newspaper articles that involve mathematics, technical manuals needed on the job, and machines where the operator must perform mathematical calculations. Such tools provide opportunities for discourse while at the same time helping learners see the connections between school and out-of-school mathematics.

The NCTM Assessment Standards

Since the before the original formulation of NCTM's *Curriculum and Evaluation Standards*, there was concern that until problem-solving and reasoning skills became part of national assessment measures, there would be little incentive for making problem solving and reasoning the focus of the mathematics curriculum. Fortunately, assessment measures are changing. Students taking the Scholastic Aptitude Test (SAT) this spring will find that some questions are no longer multiple choice, that there is increased emphasis on interpretation of data, and that calculators are allowed when taking the test. Indiana is like many states in that the testing program for children in public schools will include a performance assessment component starting in 1995. For the performance part of the test, students will be given an hour or more to analyze and solve a single mathematical task or problem. Along with the answer, students will have to provide a written justification for their answer. The GED has not yet changed but given the rapid pace of change in other assessments, adding a performance component to the GED seems likely in the future.

The working draft of NCTM's newest standards document, the *Assessment Standards for School Mathematics* (NCTM, 1993) was written to show how state and level assessment should change, but, more importantly, to explain how classroom assessment should change to match changes in the mathematics curriculum. General themes of the *Assessment Standards* include (a) assessment should reflect the mathematics that is important for individuals to learn, (b) assessment should enhance learning, and (c) assessment procedures should allow students to demonstrate knowledge in a variety of ways. These principles emphasize the connection between assessment and good instruction and point to the fact that assessment in numeracy classes should include a variety of mechanisms by which learners can prove to both instructors and themselves that they are able to solve challenging problems.

SCANS

At about the time the original *Curriculum Standards* were published, a more general but complementary project was undertaken by Lynn Martin, United States Secretary of Labor. The committee assigned to the task became known as the Secretary's Commission on Achieving Necessary Skills (SCANS) and was charged with (a) defining the skills needed for employment; (b) proposing acceptable levels of proficiency, and (c) suggesting effective ways to assess proficiency (SCANS, 1991). Unlike NCTM, which is a group of individuals who are involved in the delivery of mathematics instruction, the SCANS commission was primarily comprised of individuals from the private sector and looked at education from the perspective of consumers. That is, SCANS considered what employers wanted job applicants to know.

Meetings, surveys, and discussions with union and industry leaders led the SCANS commission to the conclusion that the world of work was changing. In the words of the commission:

> A strong back, the willingness to work, and a high school diploma were once all that was needed to make a start in America. They are no longer. A well-developed mind, a passion to learn, and the ability to put knowledge to work are the new keys to the future of our young people, the success of our businesses, and the economic well being of the nation. (SCANS, 1991, p. 1)

This finding was hardly a surprise, and it clearly complemented the view of the work on which the NCTM documents were based. Recommendations from the report included teaching learners to be creative thinkers, decision makers, problem solvers, and to visualize pictures, make graphs, and use mathematical reasoning when needed.

Although the authors of SCANS were less concerned about how to teach than what to teach, they concluded "We believe ... that the most effective way of learning skills is 'in context,' placing learning objectives within a real environment rather than insisting that students first learn in the abstract what they will be expected to apply" (1991, p. 19). To the extent that it is possible to simulate the work environment in schools, NCTM positions on how and what to teach in mathematics are entirely compatible with positions taken by the authors of SCANS. In short, recommendations from mathematics educators (NCTM) and from private industry (SCANS) have come to the same conclusion: Mathematics instruction must change so that learners are proficient at recognizing situations where mathematical procedures are helpful and then choosing or creating the procedures necessary to solve the problem at hand. (See Chapter 2 for additional detail on SCANS and the implications of SCANS recommendations for curriculum.)

Constructing Mathematical Knowledge

Embedded in the NCTM *Standards* documents is a philosophy of teaching commonly referred to as "constructivism." Although the documents never actually use the term, it is a main part of the foundation on which those documents are based. In brief, *the constructivist philosophy is that learners must figure out concepts and ideas themselves* (see Kloosterman & Gainey, 1993). As teachers, we can present ideas but simply presenting ideas does not mean that students will learn. Learners must analyze and discuss new concepts, and see how they are related to what they already know to maximize the chances of retaining those new concepts. This notion is particularly appropriate in adult education where most of the mathematics that learners are studying is mathematics that they have seen before but never mastered. Take, for example, a problem as simple as 0.4 x 0.6. Some learners are reluctant to accept 0.24 as an answer because they are used to thinking that "multiplication always makes bigger" and 0.24 is smaller than either 0.4 or 0.6. For these learners, the "knowledge" that multiplication always makes bigger gets in the way of understanding.

Previous knowledge can also be very beneficial to learning. House roofs are commonly constructed with a 3-12 pitch, a 4-12 pitch, or a 6-12 pitch. (A 3-12 pitch means that the roof raises 3 feet for every 12 horizontal feet.) A person with experience framing a roof should be able to draw on his or her knowledge of pitch to make sense of fractions, ratios, and possibly even linear functions and their graphs. All adults have significant knowledge of mathematics on which to build. Unfortunately, instructors sometimes fail to take advantage that knowledge.

In brief, the goals of mathematics instruction are undergoing significant change. We have always wanted students to apply their mathematics skills, but in the past have spent much of our instructional time in both public schools and in literacy programs drilling students on bits and pieces of mathematics. We now know that drill has limited value in teaching mathematics. In particular, drill does little for *long term* retention of skills unless learners see how those skills can be directly relates to something they already know or want to know. Furthermore, learners who have failed to master the fragments they have been taught have been shut off from learning to apply those fragments to solve more complex home and workplace problems.

NCTM and adult literacy advocates such as the SCANS commission agree that continuing to focus on bits and pieces of mathematics is a poor strategy for many learners, particularly adults. Instead, *learners need to be actively involved in solving challenging problems*. On some of those problems, learners are bound to fail on the first and often subsequent efforts. The successful individual, however, is one who perseveres to get the job done. As numeracy educators, we need to provide emotional support to those who fear mathematics but if we only give them easily solved mathematics problems, we are failing to prepare them to solve the real-world problems they will encounter.

Implications

My purpose in writing this chapter was to familiarize adult numeracy educators with the NCTM initiatives for change in mathematics instruction with the hope that the bridge between K-12 education and adult education becomes stronger. Learners who have spent time in the workforce know what skills are needed on the job and thus are usually quite receptive to new ways of learning mathematics. Individuals without work experience have a tendency to think mathematics should be the same as it was when they were in school, and thus often resist group learning and open-ended problems. As a numeracy educator, however, it is important to teach learners important mathematics, especially the ability to attack and solve challenging problems. The public schools are doing much more of this and most industrial training programs do this. Learners need to recognize that time spent learning "pre-calculator" mathematics is time that could have been spent learning the estimation and number sense skills that calculators cannot perform.

As I close this chapter, I offer the following key questions and some speculations about the answers.

- *How important are the three NCTM Standards documents to adult mathematics educators?* Clearly, the *Standards* documents themselves are rather lengthy and do not have many examples that are explicit to adult education. However, they represent years of thinking about what is important to know in mathematics and how important mathematics concepts can be taught. It's probably not that important that adult educators read the actual *Standards* documents but it is important to know the principles outlined in this chapter and in the *Standards*. These principles give a lot of guidance on teaching mathematics, regardless of the student population.

- *How important is adult education to NCTM?* Although NCTM has traditionally been an organization of K-12 and some college teachers, members of the organization are interested in working with mathematics instructors for all ages and all levels. Shortly after attending the Conference on Adult Literacy, I attended a meeting of the staff and major committee chairs for NCTM. In a goal setting session, it came out time and again that NCTM can and should be involved in both adult numeracy and in non-traditional post-secondary mathematics education. In short, adult education is quickly becoming a priority within NCTM.
- *How easy will it be for learners in adult education settings to acquire the mathematical literacy that NCTM recommends?* While it feels good to be optimistic, in reality it will take years to implement the NCTM *Standards* in K-12, assuming they can be implemented at all. The same is true for adult education. Individuals who are looking for the "quick fix" in adult education will not find it by working with NCTM. On the other hand, the potential for long-term benefits to adult education from considering the NCTM principles is enormous.
- *Should "problem solving" mean the same thing in numeracy programs as it does in K-12 mathematics?* In the sense that problem solving means attacking a mathematical problem for which is no readily apparent solution strategy, problem solving is the same for adults as it is for children. The context of problems should be different for the two groups. As I noted earlier, adults have a substantial background of experiences on which to draw and build. If anything, making mathematics "relevant" should be easier for adults than it is for individuals who have not yet been expected to support themselves.

In short, mathematical literacy is much different today than it was in the past. As citizens, job seekers, and employees, we are expected to be problem solvers and to see ways to use mathematical reasoning in seemingly non-mathematical situations. The National Council of Teachers of Mathematics has provided us with some insights into how to teach individuals to be problem solvers. When adult educators work together with NCTM, it should make it easier for K-12 teachers to understand how life-long learning can work. It should also make it easier for adult educators to meet the mathematics needs of those in adult education settings.

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CHAPTER 10
Proceedings of the 1994 Adult Mathematical Literacy Conference

LESSONS LEARNED?

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PURPOSE

The National Council of Teachers of Mathematics (NCTM) is often hailed as the initiator of the standards-based reform of schooling. This chapter outlines this initiative, describes some of the lessons we are learning, and raises issues the adult education community may want to consider as it addresses needed changes in adults learning and teaching mathematics.

INTRODUCTION

Three documents: *Curriculum and Evaluation Standards for School Mathematics* (NCTM, 1989), *Professional Standards for Teaching Mathematics* (NCTM, 1991), and *Assessment Standards for School Mathematics* (NCTM, Draft 1993) are the tripod on which our efforts rest. Although each was published separately, the messages which are described in the previous chapter, reside in the whole of the three documents.

During the early 80s, our membership, through the leadership of several of its major committees, saw the need for us to articulate a vision of what mathematics students should know and be able to do. It was not until 1989 that the *Curriculum and Evaluation Standards for School Mathematics* was completed. This document also provided a flavor of the teaching, but there was a need to be more explicit. As it was being completed, the Council turned its attention to its vision of teaching, evaluation of teaching, and professional development. As we began to see changes in schools we realized that many assessment practices, both classroom and external, needed to be brought into line with content and teaching. So now we are in the process of producing the third document building on the first two documents and focusing on assessment.

The first lesson learned from this process was the importance of establishing a need for change. The need for articulating a new vision was established by the membership of NCTM and by the study of the conditions of mathematics education in juxtaposition to the changing world of today. Without this need, there would have been little hope for moving ahead with developing the vision of change.

PROCESS OF DEVELOPING STANDARDS

In developing the three set of standards, we have used slightly different models but generally, we have brought together groups of people to draft a document, spent a year gathering reactions to the document, and then reassembled the groups to complete the document. After the final editing, the document has been distributed to membership and leaders in other professional organizations, and made available to all stakeholders. The next paragraphs describe the process of developing the first set of standards and briefly touches on the differences in the process used to develop the other two documents. This section ends, as do each of those that follow, with some of the lessons we have learned.

Curriculum and Evaluation Standards for School Mathematics.

By the middle 80s, the Board had approved the concept and directed the president to seek funding to develop standards. At that time, no outside foundation or government agent approached was willing to fund such a project. In May 1986 the Executive Board of NCTM, acting on the recommendation of the Board who had approved the spending of the Council's own monies, finalized the plans to move ahead. At that time, it became clear than not only curriculum standards should be developed but also evaluation standards to give guidance in evaluating students and programs.

A commission to oversee the project, a director and working group chairs of grades K-4, 5-8, 9-12 and evaluation were appointed. Later the full team consisting of teachers and other mathematics educators along with assessment specialists and mathematicians was named. During the summer of 1987, the working groups met for two weeks to draft a document. Later that summer after working individually, they spent two more weeks together smoothing the draft.

The draft document was available for comment during the 1987-88 school year. It was sent to members of NCTM and to leaders in other professional organizations, especially those whose focus is clearly mathematics. Copies were available at our regional meetings at which time the working groups and commission presented the vision and requested feedback. The Mathematical Sciences Education Board held focus groups of parents, business people, and mathematicians. Many affiliated groups and college classes focused on the document and gave extensive comments. NCTM requested specific people to do in-depth reviews of the documents, some focusing on the document as a whole and some on parts or issues. About 2000 responses to the document were received; most applauded the direction although some faulted the lack of examples and pedantic writing. The critical issues were discussed by the commission and working groups before moving ahead with the revision.

The next summer was spent revising, the fall in editing and the document was released in March of 1989. Every member of NCTM received a copy as did the leaders of those organizations who endorsed or supported it. It has been reprinted several times and still remains in demand.

Professional Standards for Teaching Mathematics

The process of developing these standards differed from first document in that there were lead writers for each of the four sections. Groups met to discuss the proposed standards, then the lead writers produced drafts often working closely with one of the other members of the group, with the other lead writers and the project director. After receiving feedback from the group, the lead writer was responsible for completing the draft. NCTM held the special focus groups to receive reactions; the project director and the lead writers did the majority of presentations at conferences. Feedback was collected and catalogued in a much more systematic way than the previous effort. It is evident from both completed documents, that the information gained during the year of discussion helped shape the final version.

Assessment Standards for School Mathematics

The development of this document was similar to the first document in that all members were expected to write and to contribute throughout the weeks together. The main difference in the process was the hiring of a full time outreach coordinator who was responsible for organizing the feedback and synthesizing the reactions. Many other groups stepped forward to hold focus groups and to have sessions at their meetings. Reviews were solicited from a diverse group representing some views that we felt we would not otherwise obtain as well as from within the mathematics community. The initial printing of 20,000 copies of the draft was double that of the first document and 5,000 more than the second document. Due to the multitude of requests, subsequently 10,000 additional copies were printed.

Lessons learned

1. Process. There are several aspects of the process of developing standards that we would recommend considering. It is important to identify a small number of people with varying views and expertise but who are representative of your membership or your constituents. It was extremely important to bring the groups together to coalesce and to get away from all the other pressures of their busy lives. When the entire group of writers were responsible for the draft, there was a real ownership and responsibility that has staying power.
2. Draft. We made no attempt to have a polished, finished document when the draft was released for reactions nor did we send it out in bits and pieces. The membership and others were immediately aware of the thinking to date and were not left to guess what would be there, they realized it would not be a finished project until we received their input, and they were brought into the process as quickly as possible. Each effort has also increased our expertise in analyzing and synthesizing comments and reactions.
3. Dialogue. One of the greatest strengths of the whole process was the in-depth conversations over the draft. Not only did the dialogue give us valuable feedback, but it opened and gave focus to discussions unlike any we had ever experienced. It also gave a first step in awareness; the community was aware the document was coming and anxious to see its input.
4. Negotiation. There was always a struggle between being visionary and producing a useable document. There was a struggle not to blame the past, but look to the possibilities of future.

PROCESS OF CHANGE

Change begins with awareness of the need to change and the direction of change. NCTM and its affiliates took many steps to make our members and others aware of the messages of the documents. The Council had each of its standing committees address the standards in ways appropriate to the committee's charge. For example, all the conferences and journals included sessions or articles on the standards and what they mean to the classroom teachers. Our affiliated groups, now over 250, often made the standards the focus of their meetings and publications. We joined with some of our national affiliates to sponsor "Leading Mathematics into the 21st Century." This series of four conferences which brought together teams of leaders from each state had a lasting impact on the awareness of the first document. Many of these teams held similar conferences in their states. For the first two documents we retained a public relations firm to help with press conferences, videos, and public services announcements. Awareness plans are underway for the third document.

The implementation phase has leaned heavily upon states, local districts, and individuals although the Council has continued to work with many other groups, to develop support materials which are described in the next section, and to keep the vision at the center of our mission.

Lessons learned

1. Concerted effort. Most of the Council's energies have been directed to making the vision of the standards a reality. The mathematics community and other professional groups have played an important role as partners in this change.
2. Periodical highlighting. Each separate document has given us the opportunity to bring to the forefront the message of change. We have sustained momentum while refining the vision through this and other efforts
3. Support. Many of the efforts of implementation are heroic, individual efforts by teachers or by others. There is a need to understand more systemic change and provide the necessary support.
4. Plan. There is a need for a variety of suggestions of ways to proceed in making change. There is no one way, but school systems need models and ways to communicate with each

other as they make change.
5. Change. There has been a reaffirmation that change is slow and takes time and commitment.

INTERNAL SUPPORT MATERIALS

As the first set of standards were being developed, there was a realization that support materials would be needed. A special initiative of publications, called the Addenda Project, produced a series of curriculum examples. These twenty-two booklets contained teaching and assessing ideas to amplify and exemplify the content standards at various grade levels. Many other publications also looked at the implementation of the standards.

In addition to these and many other publications, we have produced awareness materials such as executive summaries and brochures. Additionally, speakers kits containing speaking points and transparencies were made available as was the video produced to describe the overall message of the curriculum standards. Now we are turning our attention to the assistance needed for professional development and to the awareness of the assessment document.

Lessons learned

1. Additional materials. The standards describe many changes, but there is a need for concrete examples and continued efforts to assist your own constituents in making change.
2. Continued ownership. It is important to have a core group such as a professional organization that continues to wrestle with issues that arise during change, that coordinates efforts, and feels ownership in the process.

SUPPORT FROM OTHER GROUPS

There is no doubt that the reform movement is larger than mathematics; we cannot make the needed changes in mathematics without a broader movement. Even within the discipline of mathematics, there are many other parties beside NCTM need to be involved. We have been fortunate in the support and leadership of many other groups.

The Mathematical Sciences Education Board was begun about 10 years ago by the mathematical professional societies as a force to bring the community together. Part of the charge to this group was to study and advance the needed changes in mathematics education. It is this part of the charge that made being a part of the National Research Council appropriate. One of its first major tasks was to produce *Everybody Counts: A Report to the Nation on the Future of Mathematics Education* (1989). This readable publication documented the state of the nation in regard to mathematics education and clearly articulated the need for change. The Board also has been active in outreach activities with the states, with professional organizations outside of mathematics, and with business and industry.

NCTM is the only major organization whose sole focus is on school mathematics which makes it easier to work closely with the collegiate mathematical professional organizations whose support for change is essential. They have helped shaped and have participated in many of the activities. Today, they are examining their curriculum, instruction, and assessment; it will continue to be a collaborative effort as we strive to understand the needs of each group.

As we began to help teachers see standards-based instruction in the classroom, we realized that we needed ways to portray other than in print. Although the Council has some videos, we were fortunate that the Annenberg Foundation has funded several video projects and that the Public Broadcasting Stations have undertaken a major project, MathLine. This service will allow for teachers across the nation to be part of interactive teleconferences and sharing on an on-going bases. They will be able to see and to interact with teachers who are in the process of change.

Texts and tests are still an important part of the lives of teachers and students. NCTM has held special conferences with publishers each year to gain their input and to keep them abreast of the proposed changes. In turn, when the teachers spoke the publishers listened. We are beginning to see substantial changes in curriculum rather than the initial rush to superficial labeling.

There is no doubt that the standards appeared at an propitious time. America 2000 which was recently expanded and replaced by the Goals 2000 legislation is congruent with many of the goals of the mathematics standards. In particular, the call for higher standards for all students is central to both. The governmental agencies in their effort for systemic reform have been a major support of activities of the mathematics community in their efforts for standards-based schooling.

Lessons learned

1. Importance of others. There is no doubt that the forces needed are much greater than any one professional organization and that it takes the many different stakeholders to even begin a systematic change.
2. Coalescence of vision. The vision must be powerful enough for many to see its benefits and to see a part for them in making it a reality.
3. Change in mission of professional organizations. There is a need to relook at the mission of a professional organization from one whose focus is more inward (serving its members) to one of working with a variety of new constituencies.

MONITORING

Although some projects are underway, there is a need for a much more inclusive effort to monitor change. There is no doubt that we would have more lessons to share if more time and effort had been spent on collecting, analyzing, documenting, and synthesizing changes.

At the time we began the process of developing standards, we knew that we needed to document progress. Several committees and task forces made compelling plans yet we were only successful in obtaining funding for one of these. Fortunately, there are other efforts underway that add to the picture.

Our successful venture, Recognizing and Reporting Reform in Mathematics Education, is funded by the Exxon Education Foundation and is studying schools who specified they were in the process of change. From this study will come useful and deep descriptions of "sites of reform" from across the nation. (For a more thorough description of the project, see Ferrini-Mundy, 1993.) Complementary to this effort are two surveys of teachers and others as to their knowledge and use of the standards. The results of the first survey, The Road to Reform in Mathematics Education: How Far Have We Traveled? (Weiss, 1992) and the other should be available later this year.

Several other studies of school-based reform are underway such as those described at the AERA Annual Meeting in Atlanta (National Center for Research in Mathematical Sciences Education, 1993). These vary from case studies of schools to studies of intervention studies. One of the working groups of the National Center for Research in Mathematical Sciences Education is charged with examining the implementation of reform. Additional information will continue to be available from this working group.

Additionally, there is information from the six mathematics assessments of the National Assessment of Education Progress (Lindquist, 1992). Understanding the trend data and the change of the assessment itself gives a picture of some of the changes that have occurred during the last decade. There will be information from the Third International Mathematics and Science Study (Robitaille, 1993) which is focusing on mathematics achievement, curriculum intentions and practices, and instructional practices in about 50 countries.

Lessons learned

1. Need. The federal government is basing reform on standards. It would have been extremely beneficial if a more careful documentation than those described above of the efforts of one group before undergoing standard development in all areas. It would also be helpful to have much more information about the implementation of the standards as groups look to revisiting their standards.
2. Difficulty. The process of documenting change is difficult because it at the school level

that we may learn the most. There is a fine balance of studying change and reporting successes. People want to know where standard-based reform is happening, but it is critical to remind people of the levels of change and that we are in progress.

CHANGING FRONTS

Part of the challenge of change is the continual changing conditions in which the change in mathematics is embedded. For NCTM, there have been three central conditions that have radically changed since inception of the curriculum and evaluation standards.

First, technology has been greatly advanced beyond where it was in the late 80s. The technological power of the graphing calculator has yet to be met with the power of what it can do for the mathematics curriculum. It alone makes much of school mathematics that many of us learned obsolete, but at the same time it becomes more crucial to understand concepts and to develop a strong mathematical sense of numbers, space, and symbols. It opens mathematics that was never available to the secondary school student. We have just begun to see the use of other technologies in our teaching and learning of mathematics. There is no doubt that this changing condition will force a refining of our vision in the near future.

Secondly, our knowledge of assessment is changing. We are no longer satisfied with knowing what students do not know, but want to know what they do know and how to build on that knowledge. There have been advances in the types of assessment that teachers are using in the classroom. We need to continue to change the external assessment along with studying many of the methodological issues.

Thirdly, the role in education of the federal government is changing. When we developed our first set of standards, there was little interest and no federal support. Today, many of the other disciplines are being financially supported in their efforts to develop standards. The recent legislation that inaugurates an independent board to oversee both national standards and state frameworks will introduce new challenges.

Lessons learned

1. Refining the vision. There is a continuing need to refine the vision to take into account the changes in society , technoglogy, and educational trends.
2. Adjusting the plan. Although one purpose of standards is to influence educational trends, there are often other forces that require adjustment of one's own plans.

SUMMARY AND IMPLICATIONS FOR CONFERENCES PARTICIPANTS

The standard movement has given focus to the activities of the Council as well as to the broader mathematics education community. The lessons we have learned are many, but perhaps the three most important lessons are a reconfirmation that change is a difficult, complex, long-term process; success forces more scrutiny and more responsibility; and the more one does the more there is to be done. The development of the standards is only the first step; one must keep in mind the next steps of supporting materials, collaborating with others, monitoring progress, and repositioning and refining the vision.

There is no doubt in our minds that these efforts have been worthwhile, we are seeing changes in mathematics education on many fronts and more importantly in many classrooms. Are we nearer our vision? Yes, but we have a long way to go. It is exciting to see the adult education community wrestling with some of the same issues and we look forward to continuing this dialogue. A few questions follow that, individually or collectively, you may wish to address as you look to ways to improve the opportunities of adults to learn mathematics in this technological world of today.

• What are the underlying needs of the adult community that require a change in the learning, teaching and assessing of mathematics for this audience? Is the community ready for such a change? If not, what steps may need to be taken prior to developing standards?

• What are the beliefs of the adult community as to who can learn and who needs to learn mathematics?

• What are the lessons from the experiences of NCTM can be incorporated in a process of setting and implementing mathematics for adult learners and teachers?

• What parts of the NCTM Standards could be used or modified in developing standards for adult learners? What parts need to be changed? What other standards should be added?

• How can the NCTM community assist in the process if the adult education community decides to undertake such an effort? What are the benefits to the adult education community? to the mathematics community?

The National Council of Teachers of Mathematics has learned many lessons in developing standards and assisting in making the vision of the standards a reality for all students. Others would have described different lessons and others may say we have not learned all our lessons well. We are, however, ready to share what we have learned with groups who are also striving to improve the educational opportunities of all. In so doing, we will learn from the efforts of others and together we can open more doors to learning for all students in all disciplines at all ages.

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Chapter 11
Proceedings of the 1994 Adult Mathematical Literacy Conference

The ABE MATH STANDARDS PROJECT: ADAPTING THE NCTM STANDARDS TO ADULT EDUCATI . N ENVIRONMENTS

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Purpose

Since 1992, a group of twenty-two adult education teachers who call themselves **The Massachusetts ABE Math Team** have been rethinking and reforming the ways in which mathematics is taught and learned in their classrooms. The team's primary focus during 1993 was **The ABE Math Standards Project: A Teacher-generated Research Project Based on the Application of the NCTM *Curriculum and Evaluation Standards for School Mathematics* to Adult Basic Education Learning Environments.** The main funding for this project came as an award from The National Institute for Literacy Grants Program. Additional support came from the Massachusetts Department of Education and SABES (the System for Adult Basic Education Support). This paper provides a summary of that project.

Overview

How do teachers transform their instructional practice to better serve learners' needs? The most powerful way they can do that is to join with their colleagues to question their own practice and to support each other as they risk change within their own classrooms. There are two necessary conditions for making meaningful change. The first is dissatisfaction with the status quo. Experienced as well as new teachers on the Massachusetts ABE Math Team each had stories of the persistent challenges they had met over the years to engage adult learners in the acquisition of mathematical skills. All the teachers in this project knew that there was some element they wanted to improve in their classes. The second condition is having a vision of "what might be." The team members first got a glimpse of this as they read the NCTM *Curriculum Standards* and then articulated a vision particular to adult basic education by writing a set of their own standards. Their final document describes what they value as important mathematical content and instructional practice. The NCTM and the adult standards energize this group of teachers to set high goals for themselves and their students. In no way does their definition of "standards" denote external coercion, prescriptive lists or standardized formats. In every way, their definition of "standards" promotes guidance for the continuous improvement of teaching and learning.

Project Components

The purpose of The ABE Math Standards Project was to address the application of the National Council of Teachers of Mathematics' *Curriculum and Evaluation Standards for School Mathematics* to adult basic education learning environments. To accomplish this, the Massachusetts ABE Math Team participants:

1. studied and discussed the NCTM K-12 *Standards*;

2. developed an initial draft NCTM-based standards for four adult basic education instructional environments: Adult Basic Education (ABE/basic literacy), Adult Secondary Education (ASE/GED), English as a Second Language (ESL), and Workplace Education;

3. implemented selected draft standards in actual programs in field-based teacher research situations;

4. produced and disseminated two volumes:

    The Massachusetts Adult Basic Education Math Standards, a revised version of the initial draft in light of the implementation findings, and

    Implementing the Massachusetts Adult Basic Education Math Standards: Our Research Stories, a compilation of the teacher-research papers, each one telling the story of a teacher's journey within her/his classroom as the team began to implement the vision.

Highlights from The Massachusetts Adult Basic Education Math Standards

The Massachusetts ABE Math Team, after a year of study, reflection and practice, proposes twelve standards which can be used to inform and guide mathematics teaching in adult basic education. In the complete document (61 pages), there is an introductory narrative which provides a rationale for the inclusion of each standard, and which discusses the application of the standard to the four adult basic education mathematics learning environments. Interspersed within this text are vignettes or anecdotes which illustrate the concept or methodology of the standard. These items come from the teacher-research phase of the project. Finally, there is a summary of guidelines for curricular design.

The first four standards: problem solving, communication, reasoning, and connections, and the final assessment and evaluation standard are the core of *The Massachusetts Adult Basic Education Math Standards*; they form the basis for all recommended methodologies which follow. The other standards deal with individual content or skill areas. While written with teachers in mind, the hope is this document will serve as a point of departure for publishers, test-developers, and funding agencies across the nation as well.

The twelve standards, alorg with a short quote from each are as follows:

Standard 1: **MATHEMATICS AS PROBLEM SOLVING**

"Adult basic education mathematics teaching must involve authentic tasks centered in authentic problems using multiple problem-solving strategies. Isolated non-contextual computation drills are not enough."

Standard 2: **MATHEMATICS AS COMMUNICATION**

"Much of the mathematics adults encounter everyday requires interaction between two or more people... it is essential that the mathematics curriculum of the adult basic education classroom involve and include strategies for shared problem-solving experiences and communication of mathematical ideas."

Standard 3: **MATHEMATICS AS REASONING**

"Adult basic education mathematics instruction must help the adult learner know that he/she has the power to do mathematics, and has control over the success or failure of that effort. This power cannot exist unless the learner uses reasoning to justify his/her own thinking... It is also essential that concrete materials be made available to adult learners in supporting their reasoning, whether inductive, deductive, spatial or visual."

Standard 4: **MATHEMATICAL CONNECTIONS**

"In the adult basic education classroom, curriculum design must include approaches to making mathematical connections which allow the learner to view mathematics as an integrated whole that is connected to past learning, the real world, adult life skills, and work-related settings."

Standard 5: **ESTIMATION**

"Estimation is probably the most used and useful skill for adults and continually plays an important role in the adult learner's life."

Standard 6: **NUMBERS, OPERATIONS, and COMPUTATION**

"ABE math instruction should stress the development of conceptual understanding for arithmetic operations as well as the procedural knowledge of computation and number facts. This means providing the learner with opportunities to explore, explain, and develop proficiency with a variety of models for each of the four basic operations."

Standard 7: **PATTERNS, RELATIONSHIPS, AND FUNCTIONS**

"Patterns abound in the rhythm of adult lives... they also form the basis for most of the mathematics adults use--from multiplication tables to common formulas... to statistics and more abstract algebraic functions."

Standard 8: **ALGEBRA**

"As a matter of equity, algebra instruction should be made accessible to all adult learners...curriculum design must include approaches to teaching algebra which allow the learner to represent arithmetic patterns and real-world situations using tables, graphs, verbal rules, equations, and explore the interrelationships of these presentations."

Standard 9: **STATISTICS AND PROBABILITY**

"Adults are bombarded daily with results from statistical studies that can and do impact their lives. The adult learner is frequently aware that such numbers are continually used to define our existence, and generally displays a healthy interest in learning or re-learning the processes used for reaching such conclusions."

Standard 10: **GEOMETRY AND SPATIAL SENSE**

"Adult learners who attend adult basic education classes of any kind share a wealth of pragmatic experience surrounding geometric and spatial concepts. They've probably built a bookcase, drawn direction maps, laid out a garden, papered a room or tiled a floor, all the while discovering informally the rules which formally govern the study of geometry itself. Consequently, for many adult students geometry is one math topic that immediately makes sense to them and gives them confidence in their ability to learn."

Standard 11: **MEASUREMENT**

"Adults use measurement in many familiar contexts--cooking (recipes), home improvement, and career and job specific situations. Measurement is an essential life skill."

Standard 12: **EVALUATION and ASSESSMENT**

"Decisions concerning the students' learning should be made on the basis of a convergence of information obtained from a variety of sources...methods and tasks for assessing student's learning should be aligned with the learner's and the curriculum's goals and objectives."

Bringing the Vision into the Classroom

After the first draft of their standards document was completed, each of the team members faced the task of implementing these "lofty" ideas in his/her own classes. Some began creating mathematical connections. Once a week, Lee Thomas created theme-based lessons integrating math/science/social studies/reading; Karen DeCoster integrated science and math in her GED class.

Some changed the social environment: Barbara Goodridge's previously individualized GED class began working in small, cooperative groups. Linda Huntington's basic literacy class took on the atmosphere of a quilting-bee. Others, like Deb Richard and Peg Fallon, changed the focus from sole pencil-and-paper computation to creative uses of concrete manipulatives. Sally Spencer and Ken Tamarkin would experiment with new forms of assessment. In all cases, understanding was emphasized over rote learning.

Martha Merson, who had been previously involved in action research brought an initial framework and techniques that helped guide the group's work. She encouraged team members to frame a research question that was both personally compelling and that would allow one to explore the effects of changing business as usual. The questions chosen referred to the standards both in content area and in philosophy. These examples demonstrate how consciously the teachers set out to learn more about learning:

> "Will learning about statistics and probability enable my students to view their world more critically and encourage them to ask more questions?"
>
> "What kinds of mathematical skills do students use when they make a quilt in math class?"
>
> "How can I facilitate the students' transition from passive learners to active agents of their mathematical learning process?"

In *Implementing the Massachusetts Adult Basic Education Math Standards: Our Research Stories*, the teachers share their questions, methodologies, data, and conclusions. Their findings overwhelmingly confirmed their earlier hypothesis that by implementing the standards they would improve the quality of their classrooms.

Summary

As far as The Massachusetts ABE Math Team is concerned, this is just the beginning. There is much that needs to be done in order for the vision of quality math education for all adult learners to become a reality. **Curricula** modeled on these standards need to be developed for a variety of learning environments. There are few instructional materials on the market that encourage communication, reasoning, and problem solving in realistic settings. Good **materials** that help implement the standards need to be developed. Then, **staff development** that encourages teachers to take off their expert hats and begin to learn math with other teachers and students is needed. **Assessment** instruments must do a better job at supporting learning. Finally, more **research** needs to be done on how adults learn and what skills adults really need to be mathematically literate.

Implications

About five years ago, when a colleague asked me if I had heard about the new NCTM *Standards*, my initial reaction was quite negative. The phrase "mathematics standards" set off a chain reaction that went something like this...Standards are...Prescribed checklists...Imposed by those on high...A piece of paper...Does the thinking for us...Stay away if real learning is the goal...Rigid and unchanging.

But, people I respected in the mathematics education community were all abuzz about how this was not the case about these standards. So, I got myself a copy and I can say that this document and the reform activity that has revolved around it make it one of the most powerful instruments for changed that I've seen since I entered education 25 years ago. Now, when I think of "standards", what comes to mind is...A vision of what might be...

An articulation of our best thinking at a certain point in time... A document rich with examples for creating a community of learners.

In 1990, a small group of us in adult basic education who were inspired by the *Curriculum Standards* went to NCTM to ask the board to extend their reform agenda to adult learners. We felt strongly that the goals set by NCTM for mathematics education of today's youth should be the goals for the mathematics education of today's adults. We stated:

> The NCTM has pledged itself to four societal goals in its Standards: mathematically literate workers, lifelong learning, equity of opportunity, and an informed electorate. We ask you to include the adult population who are today's workers, currently engaged in lifelong learning, who are now seeking the opportunity that they may have been denied, and who must increase their understanding of today's issues as informed citizens.
>
> The NCTM has articulated five educational goals for students: learning to value mathematics, developing confidence in their ability to do mathematics, becoming problem solvers, and communicating and reasoning mathematically. These goals are as sound for adult students as they are for youth.

The results of the Massachusetts ABE Math Team's research serve to confirm this original thinking about compatible goals. What is significant, too, is the profound impact that students and teachers claim that the process of reforming and rethinking mathematics in the spirit of the standards had on them. ABE teacher Catherine Coleman concludes her research paper this way:

> This project has been a learning experience not just for my students but for me as well. I have seen the excitement and personal involvement...when activities are hands-on and related to their lives. I have changed my practice quite a bit. I have tried to incorporate small-group, cooperative lessons into more lessons, and I have begun to use manipulatives in my math and science lessons. To me, the NCTM *Standards* represent a philosophy of education...which encourages independent thinking and inquiry, which challenges students to make conjectures to validate their thinking and to effectively communicate their ideas. As I think about how this applies to my adult learners, one word comes to mind -- empowerment. (Massachusetts ABE Math Team, 1994)

There is much work left undone in this area of study. While the team found many answers to their questions, many more questions surfaced during the research or were only touched upon. Three general questions were implicit to this project and need serious attention by all those who provide education and training to adults:

- What are the mathematical skills and abilities that are most important for adults?
- What are the most effective ways for adults to acquire those important mathematical skills and abilities?
- How do we assess an adult's mastery of those important skills and abilities?

Several questions arise as a result of the standards documents:

- Are the messages of the NCTM *Standards* and the ABE Standards ones that can and should be embraced by the larger adult education community, or at least be used as a catalyst for wide discussion?
- Are the NCTM *Professional Standards* and *Assessment Standards* applicable to adult learning environments?
- How do the changes suggested by the NCTM or the ABE Math Team complement the SCANS reports?
- Does the vision articulated by these teachers give us some handle on how to meet the challenges surfaced in the NALS report?
- What are the implications of these standards for narrowly-focused skills based training?
- If curricular changes were made to meet these standards, what changes need to be made in the way we assess learning?
- Will commercial publishers create tests and materials that are aligned with and supportive of such reform?
- How can policy makers and funders influence math reform?
- How can mathematicians and mathematics educators on the elementary, secondary and post-secondary levels join with adult educators in reform?
- How can adult learners have input into curricular reform?

This project is an example of professional development at its best:

- How feasible is it for other groups of teachers?
- What are the supports needed if other teachers were to begin their own "vision" teams?
- How can adult education teachers join together on the local, statewide, regional and national levels to support each other in rethinking and reforming mathematics learning and teaching?

References

The Massachusetts ABE Math Team. (1994). *The ABE Math Standards Project, Volume 1: The Massachusetts Adult Basic Education Math Standards*. Holyoke, Massachusetts: Holyoke Community College SABES Regional Center.

National Council of Teachers of Mathematics. (1989). *Curriculum and Evaluation Standards for School Mathematics*. Reston, VA:NCTM.

APPENDIX A

Conference on Adult Mathematical Literacy

Agenda

Sunday, March 20

1:00- 1:30	Welcome (*Ronald Pugsley*, OVAE), opening remarks
1:30- 3:00	Small groups-share work and discuss concerns and needs in the field
3:15- 3:45	Hot issues: The calculator Debate; Innovative K-12 curricula
3:45- 4:45	Review of goals and assignment of roles for March 21-22
4:45- 5:00	Closing remarks and discussion

Monday, March 21

9:00- 9:20	Welcome (*Mary Lindquist*, NCTM; *Mary Jane Schmitt*, Massachusetts Department of Education; *Iddo Gal*, NCAL)
9:25-10:35	**Numeracy Skills: demands, gaps, and challenges** *Larry Mikulecky* (Indiana U.) *Patricia Rickard* (CASAS) Discussion
10:50-12:05	**The Current Delivery System** *Jim Parker* (OVAE) *Iddo Gal* (NCAL) *Bonnie Mullinix* (World Education) Discussion
12:15- 1:10	Lunch (Speaker: *Daniel Wagner*, NCAL)
1:10- 2:45	**Reform Efforts** *Mary Jane Schmitt*, *Barbara Goodrich* (Massachusetts ABE Math Team) *Mary Lindquist* (NCTM) *Marilyn Mays* (AMATYC) Discussion
3:00- 4:00	Roundtables discussions
4:00- 4:45	Reporting in working groups; general discussion of "next steps"
4:45- 5:00	Wrap-up; "minute papers"

Tuesday, March 22

9:00- 9:45	Sharing of activities and classroom projects
9:45-12:00	Working Groups - discuss subtopics and draft recommendations
12:00- 1:00	Lunch
1:00- 1:45	Family Math (*Virginia Thompson*, EQUALS)
2:00- 3:45	Reporting from working groups; general discussion of "next steps"
3:45- 4:00	Wrap-up; "minute papers"

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APPENDIX B

[Editorial Note: the following activity was conducted at the Conference on Adult Mathematical Literacy to gauge the perspectives and practices of the conference participants on this important issue. Consider conducting the same activity with your colleagues as a professional development exercise; set aside 45 - 60 minutes to "survey" participants, to record responses on a graph (or "consensogram"), and for discussion and reflection.]

Calculator Usage in Adult Basic Mathematics

Martha Gilchrist and Myrna Manly

Instructions: Place yourself at one of the following levels. Base your decision on your accumulated experience in adult education. Do not expect a perfect fit; use the "practices" description as a tie-breaker if you are undecided.

Characteristics of the levels for the Calculator Usage Consensogram:

Level 1
Beliefs: Computation algorithms are the building blocks of mathematics. Students must be skilled at using them before they proceed to higher-level applications.
Practices: Does not allow the use of calculators in basic math classes. Emphasizes the mastery of traditional algorithms through drill and practice.

Level 2
Beliefs: Except for a few with true disabilities, everyone can learn to perform paper-and-pencil calculations. Moreover, those who, as adults, finally master skills that eluded them as children feel a great sense of accomplishment and increased self-esteem. Without a knowledge of the basic skills, adults are handicapped when trying to understand the applications of mathematics. They become mindless button pushers when they rely on calculators.
Practices: Introduces the use of calculators on an occasional basis perhaps for checking student work or an exploratory activity to recognize patterns. Does not allow the use of calculators on tests.

Level 3
Beliefs: A strong number sense and operation sense are the foundation for mathematical understanding. Students build these senses by using calculators and by knowing the basics of computation. Relying only on written computation in today's technological society is foolish. Likewise, a complete reliance on calculators breeds lazy thinkers.
Practices: Enforces a blend of calculator usage and computation skills. Stresses estimation skills to provide approximate answers and calculator use for exact answers if required computations are tedious. Introduces sense-making activities for the understanding of algorithms. Allows the use of calculators only on portions of tests.

Level 4
Beliefs: By insisting on competency with computational algorithm, we impose a sense of failure on adults who are returning to the study of basic mathematics. This is unnecessary and unproductive. The use of calculators allows students to gain access to mathematics beyond the level of their computational skills.
Practices: Allows students to judge for themselves whether the use of a calculator is appropriate for the situation. Since it is natural to seek the most efficient method, students will realize the importance of mental calculations and estimation. Allows unlimited use of calculators in the classroom and on tests.

Level 5
Beliefs: In adult basic mathematics, it is futile to spend time on the algorithms of computation. Instead, we should exploit the calculator's power to raise students' performance levels and enable them to be immediately competitive in today's workforce.
Practices: Insists on student profiency with the calculator to solve problems of all kinds. Makes no attempt to increase students' levels of skill with obsolete computational algorithms.

APPENDIX C

How to Contact the Adult Numeracy Practitioners Network

To join the network and receive its newsletter, please write to your regional representative. To obtain other information, contact the network coordinator. To submit materials for the Newsletter, write to the editor, Ellen McDevitt (see below).

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APPENDIX D

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