A FRAMEWORK FOR ADULT NUMERACY STANDARDS:
The Mathematical Skills and Abilities Adults Need
To Be Equipped for the Future

by

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A Framework for Adult Numeracy Standards:
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The terms "mathematical literacy" and "numeracy" are used interchangeably in
this document. Both terms should be viewed as loosely referring to the aggre-
gate of skills, knowledge, beliefs, patterns of thinking, and related communicative
and problem-solving processes individuals need to effectively interpret and han-
dle real-world quantitative situations, problems, and tasks. (Proceedings of the
Conference on Adult Mathematical Literacy, March, 1994)

INTRODUCTION

In October 1995, the National Institute for Literacy (NIFL) funded eight planning
grants for system reform and improvement as part of the Equipped for the Future
(EFF) project. World Education, Inc., in cooperation with five state literacy re-
source centers, accepted the grant on behalf of the Adult Numeracy Practitioners
Network (ANPN). The purpose of the ANPN Planning Grant is to begin the work
of developing Adult Numeracy Standards for adult basic education. We are aug-
menting previous work done in this area (e.g., NCTM, SCANS, Massachusetts
ABE Math Standards) by interviewing adult learners, teachers and other stake-
holders.

This project, while furthering the work of other projects, was exciting in that the
voices of the adult learner as well as stakeholders were added to the mix. Based
on all the voices along with the work done previously in the area of adult numer-
acy, the following seven themes emerged and serve as the foundation for adult
numeracy standards:

- Relevance/Connections
- Problem-Solving/Reasoning/Decision-Making
- Communication
- Number and Number Sense
- Data
- Geometry: Spatial Sense and Measurement
- Algebra: Patterns and Functions

Along with the seven themes noted above, adult learner and stakeholder voices
also gave us greater insight into affective issues. A section on Competence and
Self-confidence was added to ensure that adults' voices were heard and their
feelings considered as this document is read.
We not only asked adults what they need to know and be able to do to be productive citizens, workers, and parents, but also we encouraged the adults we spoke with to share their opinions on how math instruction should be changed. Adult learners shared how math instruction should be changed in the classroom while stakeholders tended to look at system reform issues. From the uniformity of voices of adults across the country, Recommendations for System Reform have been drafted and are reflected in the final chapter of this document.

What We Need Is an Honest List!

In March, 1994, over 100 adult educators, mathematics educators and other stakeholders in the field of adult education and training came together for three days to discuss the topic of adult numeracy. One of the major suggestions of the Conference on Adult Mathematical Literacy was that an important next step would be to develop an “honest list” of the skills and knowledge that adults really need to be mathematically literate. The participants called for a serious rethinking of the content and relevance of the adult basic education mathematics classes as they are currently taught. Through analysis of the mathematical demands on adults in today’s society, educators can refocus the adult numeracy curriculum in a meaningful way.

A Massachusetts cohort of adult education teachers, inspired by the National Council of Teachers of Mathematics Curriculum and Evaluation Standards for School Mathematics, had already begun this task in earnest. However, because the cohort reflected the input of teachers only, many participants at the conference felt that more research was needed. That research should include consideration of data from the Secretary’s Commission on Achieving Necessary Skills (SCANS) Report, other recent documents, employer and community needs assessment, and especially the opinions of adult learners.

In this report, our grassroots organization formed at the conference, the Adult Numeracy Practitioners Network (ANPN) will bring together essential documents and the many voices of adult learners, teachers, and employer and community stakeholders. Through the Equipped for the Future Initiative, an ANPN working group was encouraged by the National Institute for Literacy to carefully “listen to the data” by analyzing the transcribed tapes of twenty-one learner focus groups, five stakeholder focus groups, and five teacher study groups. In addition, the ANPN working group examined pertinent documents such as Equipped for the Future, the SCANS Report, the 1994 Conference Proceedings, the NCTM Standards, and The Massachusetts ABE Math Standards (See Table 1).

The ANPN working group was struck by the fact that all the voices — from SCANS to The Massachusetts ABE Math Standards to the focus group partici-
pants -- resonate, all be it with diverse perspectives. It is this resonance that must and will guide our "honest list".

Table 1

Putting Together the Honest List

Responding to SCANS Research

The SCANS Report for America 2000, What Work Requires of Schools lists the following "foundation skills":

1. **Basic Skills**: reading, writing, mathematics (arithmetical computation and mathematical reasoning), listening, and speaking;

2. **Thinking Skills**: creative thinking, making decisions, solving problems, seeing things in the mind's eye, knowing how to learn, and reasoning; and

3. **Personal Qualities**: individual responsibility, self-esteem, sociability, self-management, and integrity.
"The basic skills are the irreducible minimum for anyone who wants to get even a low-skill job . . . the thinking skills, by contrast, permit workers to analyze, synthesize and evaluate complexity." (SCANS, p. 17)

SCANS holds that even these foundation skills are not enough. They must be integrated with other kinds of competencies to make them fully operational. Competencies such as managing or using resources, interpersonal skills, information, systems, and technology are needed by everyone from the entry level or unskilled worker to managers and executives.

The seven adult numeracy themes in our Framework reflect this "more than the basics" slant. Relevance/Connections, Problem-Solving/Reasoning/Decision-Making, and Communication combine with the four content areas of Number and Number Sense, Data, Geometry: Spatial Sense and Measurement, and Algebra: Patterns and Functions to deliver an up-to-date, SCANS-friendly definition of mathematical literacy.

Building upon The Massachusetts ABE Math Standards

The Massachusetts ABE Math Standards posited Problem-Solving, Communication, Reasoning, and Connections as the four over-arching standards for mathematical literacy. Through ANPN's further research, these four standards, often referred to as "process" standards, were consolidated into three adult numeracy themes: Relevance/Connections, Problem-Solving/Reasoning/Decision-Making, and Communication. Responses showed that it was difficult for individuals to differentiate between problem-solving and reasoning, both key skills in decision-making. Our data also revealed that the issue of relevance frequently occurred.

The remaining seven MA ABE Standards have been integrated into four adult numeracy content themes. Number and Number Sense includes two MA ABE standards, Estimation and Number, Operations, and Computation. Data is similar to the MA ABE standard called Statistics and Probability. Geometry: Spatial Sense and Measurement incorporates two MA ABE standards, Geometry and Spatial Sense and Measurement. Two MA ABE standards -- Patterns, Relationships, and Functions and Algebra -- correspond to the adult numeracy theme, Algebra: Patterns and Functions. This reorganized structure is a reflection of the words of adult learners, teachers and stakeholders as they told us about the math that they need and use.

The final standard of The Massachusetts ABE Math Standards is Evaluation and Assessment. The Framework for Adult Numeracy Standards, while not choosing to include a separate theme to address these topics, addresses assessment
under System Reform. Many focus group participants saw evaluation and assessment as issues that need to be approached through system reform efforts.

**Connecting to Equipped for the Future’s Four Key Purposes**

The Equipped for the Future (EFF) project focused on goal 6 of the National Education Goals which stated: “By the year 2000, every adult American will be literate and will possess the knowledge and skills necessary to compete in a global economy and exercise the right and responsibilities of citizenship.” When asked what they needed to compete in a global economy and exercise the rights and responsibilities of citizenship, adult learners responded with four key purposes:

- to have access to information and orient themselves in the world;
- to give voice to their ideas and opinions and to have the confidence that their voice will be heard and taken into account;
- to solve problems and make decisions on their own, acting independently as a parent, citizen and worker, for the good of their families, their communities, and their nation; and
- to be able to keep on learning in order to keep up with a rapidly changing world.

The Framework for Adult Numeracy Standards supports these four key purposes through the seven adult numeracy themes. Literacy for Access and Orientation includes “access to the broader world of ideas and opportunities that surround them and they know literacy — including the ability to work with numbers as well as read and write for themselves -- is the price of the ticket.” (Equipped for the Future, p.11) The four content themes: Number and Number Sense; Data; Geometry: Spatial Sense and Measurement; and Algebra: Patterns and Functions provide access to the world of mathematical thought. Literacy as Voice refers to adults’ ability to communicate to others what they think and feel. The Communication theme addresses this issue and is considered a key process that is integrated in all other math areas. Literacy for Independent Action reflects adults’ desires to be able to act independently and make informed decisions. All focus group participants in the Adult Numeracy project could clearly describe how decisions were made involving math. The process theme Problem-Solving/Reasoning/Decision-Making is an outcome of their comments. The fourth key purpose -- Literacy as a Bridge to the Future -- explains why adults participate in adult education programs. They realize that education is a key to future success, not only for themselves but for their children. Over and over again, the adult learners in our project shared that a key reason for wanting to learn math was to help their children be successful. In essence, they saw the importance of our third process theme, Relevance/Connections.
The ANPN Planning Project for System Reform sought to discover what math adults needed to accomplish the EFF key purposes in the roles as parent, worker, and citizen. Focus group participants were specifically asked what math they need to know and be able to do in order to be successful in their roles as parent, worker, and citizen. The feedback from these questions is integrated throughout the Framework for Adult Numeracy Standards. Table 2, on the following page, compares ANPN's Numeracy Themes with The Massachusetts ABE Math Standards, Equipped for the Future, and SCANS.

How Much Closer to the "Honest List" Are We?

This document is not a set of standards, but a framework for developing standards. Sometimes one has to step back before really going forward. The ANPN is being true to the data collected. Through this project, ANPN has spent an enormous amount of time listening to learners, teachers, employers and other stakeholders in a systematic, structured manner. This has given us a rich base from which to derive the “honest list”, the next step.
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<th>Equipped for the Future's Key Purposes</th>
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| Basic Skills: Arithmetic and Mathematics |
METHODOLOGY

The ultimate goal of the Adult Numeracy Practitioners Network Planning Project was to change adult numeracy education within larger reform of the ABE system. To accomplish this, two objectives had to be met. First, the project would create opportunities for teachers, stakeholders, and specifically, adult learners, to participate in the discussion of math knowledge and skills needed by adults in their roles as parents, workers, and citizens. The second objective was to develop a framework for math content standards and an initial plan for system reform around adult numeracy. This project was designed and executed with those two objectives in mind.

DEMOGRAPHICS

ANPN has involved hundreds of learners, teachers, and other stakeholders during this project. We gathered data from seven states across the nation, for a total of nearly 300 individuals participating in some phase of data collection. (See appendix.)

Adult Learners

Twenty-one Learner Focus Groups from seven states participated in this project, including six each from Illinois and Virginia, two from Ohio, one from each of the New England states of New Hampshire, Vermont, and Rhode Island, and four from Oregon. There were 171 adult learners, all of whom were enrolled in adult education mathematics classes, participating in the Learner Focus Groups. Over half of the learners were female (59% females). Almost three-quarters (71%) of the learners came from urban areas rather than rural. Since a key role for adults is that of parent, it was interesting to note that 69% of adult learner focus group participants were parents. There were more unemployed than employed adult learners (60% unemployed).

Efforts were made to gather information from regions across the country as well as diverse groups of learners. Of those adult learner focus group members, half were white. About a quarter were African American (26%). Hispanics represented 12% of the adult learners. Seven percent were Asian and 3% were Native American. The ethnic background of two percent of the adult learners was unreported.

Adult learner focus groups came from a variety of adult education classes. Almost half (49%) were participating in GED classes, while just over a quarter (26%) were Adult Basic Education class participants. The other 25% of the adult learners were involved in other adult education programs such as English for Speakers of Other Languages, workplace, and developmental college courses.
And, although data was not collected on the number of adult learners who came from correctional institutions, three adult learner focus groups were held in correctional facilities.

**Stakeholders**

In January and February, five Stakeholder Focus Groups were held in various parts of the country. The states of Illinois, Massachusetts, Ohio, Oregon, and Virginia were represented. Most of the 61 stakeholders were in roles involved directly or indirectly with adult education, training, or employment. Included were state and municipal administrators/policy makers, college and university personnel, staff developers, and publishers. Those employers who were involved in the focus groups represented food services, and the automobile and printing industries.

Data was also collected over a period of time from a "Virtual" Study Group. This group consisted of a mixture of teachers and stakeholders directly involved with adult education. There were a total of 21 "Virtual" study group participants, including researchers, graduate students, adult and mathematics educators from across the world, who communicated via a closed electronic discussion network.

**Teachers**

Data for this project was collected from five Study Groups. Forty-one teachers came from the four states of Illinois, Ohio, Oregon, and Virginia as well as a New England Regional Math Group with representatives of all the New England states. These adult education teachers came from a variety of settings: community colleges, correctional facilities, school districts (Local Education Agencies), and community-based organizations.

Although it appears that adult education teachers represent the smallest group in the data collection, *The Massachusetts ABE Math Standards* project was also considered as a data point. This project involved 22 adult educators from Massachusetts. Through the NUMERACY Electronic list and *The Math Practitioner* newsletter, the general membership of ANPN were also invited to respond to the Study Group Questions.

**PROJECT DESIGN**

There were many layers of participation from the initial design of the project to the final draft. The design included a Working Group, a Teacher Study Group for each region, a Stakeholder Focus Group for each region, a Virtual Study Group, and at least two Learner Focus Groups per region. Each of these groups pro-
vided data for the project with different groups having different levels of responsibility to the project.
The Working Group consisted of representatives from each of the regions chosen to participate in the project. The five regions/states -- New England, Illinois, Oregon, Virginia, and Ohio -- were selected because they already had active Math Teams connected to ANPN. Members of these Math Teams were to be used as a basis for choosing the Study Groups. Early in October 1995, the Working Group was asked to begin to think about the make-up of their own Study Group members. Membership would include interested Math Team members and also a key regional stakeholder.

In late October the Working Group held its first of two meetings to begin to map out the work ahead of them. The Group left the first meeting with a sense of the protocol for collecting data. The Working Group, with feedback from their Study Group members, actively participated in the formulation of the focus group questions.

Focus Group Questions

Focus Group questions were developed using input from the Working Group and each Study Group. The Focus Group Questions for the learners and stakeholders were very similar. For stakeholders, we wanted to know how they themselves viewed and applied math as well as what math skills they felt were needed by employees.

Each Learner Focus Group began with an ice breaker math autobiography activity where each learner was asked to respond to the following questions: "Where did you learn math?" "What was the BEST learning situation for you?" "Who was involved?" "What was a frustrating situation?" "Who was involved?"

The Stakeholder Focus Groups were asked to think about a time when they were learning math: "What were you doing?" "Where were you?" "How did you feel?" "What skills were you using?"

After the icebreaker, Focus Group participants were asked to respond to the following four questions:

1. Please describe a time that you made a decision using amounts, money, measurement, graphs, or another kind of math. What was the decision? How did you make it? What did you do? What skills did you use?

2. (Learner Groups) What math skills do you need to be successful as a: parent or family member? worker? community member?
(Stakeholder Groups) What math skills do you (and/or your employees) need to be successful as a:
parent or family member?
worker?
community member?

3. Working in groups of three, please look at the following math topics, then pick the four most important and order them from most important to least important. You can add any other topics that you think are important that are missing. You can also take out any topics that you don't think are important. You should agree on the top four in your group. Be ready to explain why you picked these four topics and why you ordered them the way you did. The topics were: Problem-Solving, Communication, Reasoning, Estimation, Decimals, Fractions, Percent, Algebra, Measurement, Whole Number Computation, Patterns and Relationships, Statistics and Probability, and Geometry and Spatial Sense.

4. What recommendations do you have for improving basic skills/workforce development/family literacy/workplace education (etc.) math instruction and programs?

In January 1996, the seemingly overwhelming task of convening focus groups began. Focus groups were run by Study Group members. The protocol required that two individuals share the task of running each focus group -- one individual to ask the questions and guide the discussion and the other to take notes. The protocol also specified that each focus group be tape recorded. Later, all the discussions were transcribed and forwarded to the product coordinator. All quotes by focus group members were to be verbatim. (See appendix.)

**Analyzing the Results**

In each region, as learner focus groups were completed, the Study Group met to conduct an initial analysis of their data. Topics were noted and discussed by the group, then coded after consensus was reached.

By early March all learner focus groups had met, the data initially analyzed by the Study Groups and forwarded to the product coordinator. Also, each region had conducted one Stakeholder Focus Group and forwarded the data.

The two project co-directors and the product coordinator then met to compile all five regions' data. Thematic topics sometimes varied from region to region, especially those in more rural areas as compared to more urban areas. The data was combined and recoded in order to look at the data as a whole rather than regionally. Using the coding from the Study Groups as well as our own, we
found several overall thematic areas. The five areas were Empowerment, Math Content and Skills, Using Math, Ways of Learning and Teaching, and System Reform. Each of these five areas were then further coded. (See appendix.)

The data, after being initially coded, was then entered into one large data pool. Because we wanted to ensure that whole thoughts were captured, we used a simple coding method to identify region and focus group number at the end of each data item. At the beginning of each data item, we coded for major themes. Because a quote often included themes from more than one area, all data bits were cross-referenced. For example, a comment made by a learner may have included bits of information focusing on Empowerment, Ways of Learning/Teaching, as well as on the Content area of Algebra. The quote, therefore, would be found under three areas: Empowerment, Ways of Learning/Teaching, and Content.

In late April 1996, the Working Group again met. At this meeting they were divided into groups and given all the data for a particular theme. Since there were five major themes, but many sub-topics under each theme, we decided to use the four key math topics that were chosen by focus groups as being most important. (See focus group question 3). These four topics were Communication, Problem-Solving, Whole Numbers and Estimation. (For complete results of the prioritization, see the Appendix.) Each group chose one topic to further analyze the data from learners, stakeholders, and teachers. After looking at the focus group data, they were then tasked to review other sources — The Massachusetts ABE Math Standards, SCANS, Equipped for the Future — and come to consensus about what was being said about the topic. Their task was to arrive at five key points that reflected all the data sources. Each of the five key points had to be substantiated by specific documentation from the data. (See appendix for direction sheets.)

Later, each of the regional Study Groups had an opportunity to participate in the same process but with the five content math skills groupings: Algebra/Patterns and Relationships, Fractions/Decimals/Percents, Measurement/Time, Probability/Statistics/ Graphing, and Geometry/Spatial Sense.

The feedback from the Working Group and the Study Group was then collapsed into three process themes and four content themes which serve as a framework for standards. The three process themes are Communication, Connections/Relevance, and Problem-Solving/Reasoning/Decision-Making. The four content themes are Number and Number Sense, Algebra: Patterns and Functions, Geometry: Spatial Sense and Measurement, and Data. Number includes whole number operations, estimation, money, and fractions/decimals/percent. Algebra: Patterns and Functions is a combination of algebra and patterns and
relationships. Geometry: Spatial Sense and Measurement includes measurement, geometry, and spatial sense. Data involves probability, statistics, and graphing.

In addition to the three process and four content themes, a good deal of the data categorized as mathematical "empowerment" provided us with a set of affective issues which continually emerged. These issues include learner self-confidence, attitudes about mathematics, and beliefs about what one can or cannot accomplish in mathematics. After much discussion about the title of this section, we finally came to a consensus that when adults talk about the affective aspect of math, they are referring to their self-confidence in doing math and their sense of competency around tasks involving math. Therefore, the section on adults' feelings and attitudes about math has been titled "Competence and Self-confidence."

Copies of all the primary documents (verbatim transcriptions of the focus groups, notes of study group meetings, and coding) are on file at World Education.
THE SEVEN NUMERACY THEMES
A WORKER’S STORY

The Framework for Adult Numeracy Standards has identified the "honest list" as seven themes or focal areas essential to adult mathematical literacy. Each of the following chapters enlarges upon these themes:

- Relevance/Connections
- Problem-Solving/Reasoning/Decision-making
- Communication
- Number and Number Sense
- Data: Data Analysis, Probability and Statistics, and Graphing
- Geometry: Spatial Sense and Measurement
- Algebra: Patterns and Functions

While it was interesting to extract these themes from focus and study group discussions with adult learners, teachers and stakeholders, it is the original stories that remind us how interwoven these areas in fact are:

RELEVANCE AND CONNECTIONS

My best training situation is probably work ... I got the basics in school, the really simple stuff. That wasn't so great. But I've been working at the same company for 11 years. We're really a big textile distributor, and they run quality control, so it's constantly figuring out. We're running hundreds of pieces. It's different numbers, it's never just whole numbers, it's always fractional amounts and decimals ... We get stuff from different people. We need to get so many small pieces running from a linear yard. We have to figure out cuts, how much they can get out of what. So it's just a constant use of it, the sheer volume of doing math. It's just constantly going over stuff that's made me have the decent knowledge that I have.
RELEVANCE/CONNECTIONS

I remember teachers asking me if a drop of water is falling, at what point will it pick up the highest speed, the beginning or the end? . . . Like who cares?! This is the stuff they put in there just to mess you up.

. . . they just started this when I was in 8th grade, but we had a business class where you'd go in there, and they'd give you a stock book and, you know, they'd give you so much money and you got to invest in these companies and the guy that came in there actually used the real paper and he'd tell you how much money you made, how much money you lost. You were your own broker and that was real neat. You know you invested, you put so much money in like Nike, for instance, and then McDonalds. You know, you go across the board and he tells you what you made and what you want to invest it in and what you lost. Whoever made the most money, they get something like a free pizza, whatever. And it was using real numbers . . .

Overview

In school, when math was made relevant, the concepts were better remembered. All too often, though, the school experiences involving math have not been positive or interesting. They tended to be like those described by the first adult learner. On the other hand, when adults talk about math in everyday life, they tend to perk up. When adults use math at work, at home, or in the community, they often present a brighter picture about using math. This is because the math has relevance to them. They are able to apply the math and see connections. Adults need to see connections in math — connections within the domain of math itself, connections to other disciplines, and connections to real life and work situations.

Key Findings

Math takes on greater meaning and understanding when it is directly applied in the workplace or in real-life situations. Adult learners provided specific examples of how they learned math best. "You know when I was young I used to empty out coke bottles at home and take them in to get candy bars. That's how we learned to make change." "The best learning was when I am at work using my tape measure." "I worked in a Chevrolet parts department and learned more math on my job than in school."

Many of the adult learners participating in the focus group discussions felt that their best math situation was when they learned math at work. This suggests that the math they learned on the job was directly applicable for them. "The best situation I've been
in was when I got a construction job about a year and a half ago -- being good with numbers and stuff, it made it that much more easier on me doing the job as far as measuring, weighing. Everything just seemed to flow naturally. I felt comfortable."

**Adults see little relevance or connections between math and their everyday living and working conditions.** Adults often ask, "What is it used for?" about math topics that they, thus far, have seen little relevance or connections to in their everyday living and working situations. ". . .And I started off using basically pennies for math, adding and subtracting which was real helpful. I liked math all the way up till about high school and then algebra and geometry. I kind of lost it right there. The way I seen it responding to the same question, 'What is it used for?' You don't use it unless you're teaching it or unless you're going into some kind of manufacturing type deal where you're actually making diagrams and stuff like that, but otherwise it is of no use. . . I use math every day, fractions and so on and so forth, but just don't use algebra or geometry." The adult learner quoted above shares the same sense of frustration as this stakeholder: "I remember my father standing over me at the dining room table attempting to drill into my head the algebra x, y and x + y. I couldn't understand how anyone could understand it and why anyone would want to."

**Adults feel they are more successful when they are able to link any new learning to something they already know.** This adult learner has a clear sense of how to make math learning more meaningful: "I learn better if I start off with something I already know, if you go back to the basic formula and link it to an easier way. Because the more I learn the easier it gets. I can go all the way through from basic multiplication and division all the way to algebra; if you would just refer back to the other form of math. Link it to something you already know and you'll get it; you'll remember it. I mean, you can sit down and read a book. Within 15 minutes, you've lost 80% of what you've just read, but if you link it to something else, I mean, it is that much easier to remember."

**Textbook math, and particularly word problems, seem to have little relevance to what adults perceive as math in everyday life.** The phrase "who cares" often seems to be used by adult learners when asked about word problems. "When it comes to math, you've got to remember the word frustrating. . . It gets so frustrating and it is not that I don't like it, it is like I don't care how many cookies Sally made. And I don't care how many were oatmeal and I don't care how many were chocolate chip and I could care less who ate them. You know, I'll never in my life forget that problem as long as I live. Who cares?! You cook 'em, you eat 'em." ". . .Start with the bad: the most frustrating part in math are the word problems in my class because you do them endlessly. They are senseless. You do not use them later on in life. They confuse you for days."

Adults' real math skills often don't show when they do meaningless word problems. Adults often actually use math successfully in their daily lives, yet fail to see any con-
nections to word problems presented in the class. An adult learner explained this lack of connection: "... Math was good for me. I always liked it. English was hard. I wanted to be a draftsman. I went to school at PCC. I chose building things. I succeeded, I got into that work, hurt my back. I used math for building. After my back I lost it [the math]. I feel good now -- I think some of what I knew are really coming back. Reading is hard for me -- word problems. Working with math is one thing. Reading with math is a whole other."

Implications for Teaching/Learning

Teach math in the context of real-life and workplace situations. "For all adults, mathematics learning should be connected to real life situations." *(The Massachusetts ABE Math Standards, p. 32)* When math is taught in context, adults understand that there is a practical application for that skill. "The thing that I regret when I didn't learn math was how to use a calculator. You know, problems with subtraction; how to use it in life. I can add but when it comes to things like when I want to cash my check or write checks, I've got to be able to subtract, etc.," explained an adult learner. Several stakeholders echoed the same sentiment about relevance and connections. "Whatever skills are needed, there needs to be relevance to life and application across activities." "... One of our hiring practices is to run through a simulated production. You need to develop interesting programs, have a cash register in the classroom, do medical calculations, simulate real life in the classroom. Textbooks get boring. Come visit our plant. Make it as real as possible." "Mathematics should be taught as an experience in context, not as a lecture. To this end mathematics needs to be taught using REAL problems, not textbook reality."

"Many adults already do complex math on their jobs and in their everyday life. It is important for math teachers to use this as a basis for developing new ideas or extending old ones to different places." Carrying this teacher suggestion one step further, teachers need to become more knowledgeable about the world of work in order to offer relevant math curricula.

Use learner-centered approaches to teaching to ensure that learners see the relevance of what they are learning. Math learning for adults should be relevant to their own personal goals, whether it be to attain a GED certificate, a job, or whatever. "I think a lot of times people use the excuse 'Well, I don't need to know this.' But maybe just pointing out to them why they need to know it, then it becomes more valuable to them to know it." (learner)

Adult learners need to have a voice in what is taught in the classroom. A teacher suggested, "The student has to 'buy into' the math item/concepts in order for her/him to internalize them." The teacher may think something is important for the adults to learn, but unless the learner sees the relevance to his own life, s/he finds little value in the
topic. This stakeholder further explained: "... To get a hook in them [the student] and bring them along. Because I think once they see the relevancy and understand what they can do, they will pursue it on their own. It becomes a mind set for them to proceed to the higher levels of mathematics if they desire to. But right now it is difficult. They have such low skills and they have been functioning, at least in their estimation, fine in society. You know, if they don't have a checkbook, 'Why do I need to do it? I'll never have one.' They pay cash for their needs, everything is done on a cash basis. So, in most cases, until they have a need to proceed to the next level or see that there is something beyond the level where they are already at, they come with limited experiences in many cases." Whether teachers "hook" the students or get them to "buy into" the math, adults will find the relevance when the material is relevant to their needs and goals.

**Use an interdisciplinary approach to teaching.** Math should be an integral part of other content areas. "Integrate math instruction with other literacy development — use reading and writing in teaching math and show that math content/skill (e.g. reasoning, problem-solving) are vital to making sense of the world — in other disciplines and in the workplace and as citizens and parents." (teacher)

**Link new math learning to previous learning.** Linkages should be made with other math concepts and skills as well as with other prior knowledge. A stakeholder suggested, "We need to connect prior knowledge of the learner with formal instruction in math." Not only should the new learning be connected to prior learning, but there should also be a connection between knowing how to perform a skill and being interested in performing that skill. "Shouldn't the whole thing, if you say you're not interested in something, wouldn't it be easier to try a different style to get you interested in that kind of stuff, from the teacher's perspective, to find out why you're bored with it. You know, then go about a different teacher style that would make it easier for you to learn, because once you start learning stuff, you get interested in it because, I mean, the only reason you're not interested in it is because you don't know how to do it. I mean, if you don't know how to do it, speak up and then there will be someone there to help you. I mean, find a different way to make some difference and then you won't have that problem, math especially, you've got to link it to something else." (learner)

Teach concepts before rules. "For example, teach the concept of area of a rectangle as a counting of square units. The grouping of those units into rows and multiplying units per row times number of rows is a shortcut that can be summarized in a formula, but formulas are easily forgotten with no connection to models, examples, experience, etc."

Offered one teacher.

**Help adults see the relevance of learning by seeing the "big picture".** In SCANS' terms, this would be considered the "Systems" competency, the ability to understand how all the small pieces work in relation to the total system. When adults are shown
how math skills are interconnected with one another, they begin to see relationships and the relevance of what they are learning. This stakeholder explained how she learned quicker by having the big picture: "... When we ran a business, I did most of the accounting. I had no accounting background whatsoever, but when it is your own money, you learn real fast. We were running a business and I was the office manager. But he [husband] taught me how to do that by giving me the big picture. In a very short time, I learned the concepts. You didn't have to go back and take an accounting class because when you are dealing with it in real time with real things that have real consequences, you learn pretty fast." And this stakeholder expressed his concern about seeing the whole puzzle: "One of the concerns I've noticed...[is the] need to learn, of seeing the whole puzzle before we put it together. [There] will always be a dilemma taking a person from the known to the unknown. How can you show them the unknown in its entirety before you get there? What we are doing with people now is we are telling designers before you design something, come and meet with the binders, meet with the press person, meet with the pre-press person, as a team, so that you understand what the limitations and possibilities are. As far as math class, this is the dilemma that we see in our industry — taking people from the known to the unknown and giving them a picture of what it's going to be when they get there."

Support teachers in making their classrooms more relevant and connected. Before the curriculum can be changed and any of the above strategies implemented, teachers need to be retrained. A stakeholder offered this recommendation: "We need to teach teachers to teach math concepts and connections rather than rules and to convince their students of the importance of these. Some of the rules are not that important in life, but their development is and transfers to solving problems on the job and in life."

Connecting to the Four Purposes

Learner 1, "You use math almost every day of your life, everything you do practically."
Learner 2, "You don't think about it that often; it's just there."
Learner 1, "You just do it."

The conversation between two adult learners above illustrates how math skills play a critical role in literacy. Whether it be to access information, to have a voice, to act independently, or to prepare for the future, adults connect math to their every day lives — whether it be at work, at home, or in the community.

When adults see the relevance of math, they are able to use it to their benefit. They are able to understand the wealth of information surrounding them and know what pieces of information they need to access in order to solve problems. When adults are able to make connections to everyday life and work situations, they are better equipped to express their opinions and make informed decisions as this adult learner explained:
"As a business man in a community, I use math everyday to run my business. Without it, my business would come to a standstill. I use it from controlling my inventory, receivables, payables, and accounting. It is probably the most important aspect to understand to run my business. Without having any math skills, it would probably be impossible to run my business."
PROBLEM-SOLVING/REASONING/DECISION-MAKING

My dad owned a bakery for twenty years about the late 70s, early 80s. Starting in the mid 70s he started saying that his employees, the young kids that he was hiring as helpers, baker apprentices -- wasn't much of an apprenticeship program. He said, 'They can't think anymore. Nobody knows what to do when something goes wrong. They just do whatever and go, 'I just followed the instructions.' What he was saying was they needed to predict. If it was really humid, they needed to know that the bread needed to spend less time in the steam box and they needed to know they needed to change ingredients by adding things just slightly. My dad did not know how to articulate it, but I was among those who could think. What I learned was that certain adjustments, certain ingredients needed to be added, not all of them. My dad didn't know which ones to tell somebody, but he could tell that someone was not taking all the raw data in and making a judgment on all the raw data: increasing time, predicting what was going to happen because the temperature was 75 degrees and it was 80% humidity and the bread was going to have to spend five extra minutes in the steam box. You have to change ingredients, less salt. He couldn't articulate it, but nobody who was working for him during that time period could interpret those changes critically. You talk about critical thinking. But it is basically day to day understanding of adjustments that is as important as knowing how and when to use it.

Overview

To the stakeholder above, it is clear that problem-solving, reasoning, and decision-making are three very interconnected processes adults engage in continuously, whether they are using numbers or words. SCANS classified problem-solving, reasoning, and decision-making under foundation "Thinking Skills": "Creative thinking, making decisions, solving problems, seeing things in the mind's eye, knowing how to learn, and reasoning".

The SCANS Report further defined the higher order thinking skills of problem-solving, reasoning, and decision-making: "Problem Solving. Recognizes that a problem exists (i.e., there is a discrepancy between what is and what should or could be), identifies possible reasons for the discrepancy, and devises and implements a plan of action to resolve it. Evaluates and monitors progress, and revises plan as indicated by findings. Decision Making. Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternatives. Reasoning. Discovers a rule or principle underlying the relationship between two or more objects and applies it in solving a problem. For example, uses logic to draw conclusions from available information, extracts rules or principles from a set of objects or written text, applies rules and principles
to a new situation, or determines which conclusions are correct when given a set of facts and a set of conclusions."

Reasoning is a key step in problem-solving and decision-making. Adults use reasoning to analyze information in order to solve problems which, in turn, allows them to make reasonable decisions. One stakeholder defined reasoning this way: "Reasoning. We thought in daily situations you probably see math statistics and math numbers. You're seeing different information that you need to reason and draw conclusions based on this: Is this a good sale, not a good sale? and so forth depends on the whole reasoning process. Looking at graphs and charts, looking at your paycheck and whatever -- just being presented with information and attempting to draw conclusions."

Key Findings

Math skills are integrated in the problem-solving and decision-making processes. Although it is clear that math skills are integrated in the problem-solving and decision-making process, the skills needed vary from problem to problem. One instructor stated: "On one hand we all agree that people should learn to problem solve, reason, communicate, etc. These might be called process skills and all adults do these all the time; we all strive to improve in these areas, whether or not we are in adult ed. classes. Indeed, these skills are not particularly mathematical skills, but rather skills that cover all domains. On the other hand, a person needs meaningful information and knowledge to be able to solve problems, reason about, and have something to communicate. Therefore, I guess I see these process skills as the goals of all education and learning, no matter what the domain. To me, our challenge here is to prioritize the 'specific mathematical content' that is necessary and useful to support the kinds of reasoning, problem-solving and communicating that people need to do at the end of the 20th century."

The math skills needed to solve problems and make decisions are integrated throughout the process, with more than one math operation generally being required to come to final decisions. The following adult learner provided an example of how integrated math skills are in the problem-solving process in his role as citizen: "Problem-solving, when working with the school department for our children, doing fund raisers for the sports programs our children were involved in. Being able to use fractions, multiplying, adding, subtracting, knowing your math formulas to help build playgrounds, churches, and homes."

According to SCANS (p. xvi), "Virtually all employees will be required to maintain records, estimate results, use spreadsheets, or apply statistical process controls as they negotiate, identify trends, or suggest new courses of action. Most of us will not leave our mathematics behind us in school. Instead, we will find ourselves using it on the job, for example, to reconcile differences between inventory and financial records, estimate
discounts on the spot while negotiating sales, use spreadsheet programs to monitor expenditures, employ statistical process control procedures to check quality, and project resource needs over the next planning period."

**Problem-solving is a process that includes seeking to understand the problem, and figuring out what information and math skills are important to use to solve the problem.** From comments made by learners, it is clear that the process of solving problems requires an understanding of the situation. "Communication and problem-solving seemed more relevant because, obviously, you have to communicate to understand the problem". "You have to know how to do problem-solving before you solve a problem." "You have to understand the problem in order to solve it."

Adult learners also know that without this understanding, the problem cannot be solved. "If you don’t know what you’re doing, you can’t solve it. You can know a formula or how to add, subtract, multiply, or divide, but don’t understand and then you can’t solve it."

Adult learners shared specific examples of how they defined problems and determined how to go about figuring out how to solve them: "I had bought an old truck. I was restoring it. I had to average out how much I make a month with how much I could put into it. I didn’t anticipate going to another job and getting paid less. All my numbers was from when I was making more money. This was when I was living at home when I bought this truck. Then a couple months later, I got my own apartment. I didn’t average it all out right, so I am still working on that truck. I used a lot of estimation about what I think I’m gonna need a month versus what I got to spend on that truck. I know I need to do the rest first, the basic necessities, and then how much I can play with, what I got left to entertain myself."

One employer summed up the problem-solving process this way: "Our philosophy in the workplace is ‘whatever it takes’. We will use whatever it takes to make it work, we will try it. And to be open to try."

**It is important for adults to have a repertoire of strategies and tools to solve problems.** "And then with our problem solving techniques that we use, either textbook, brain power, calculator, or whatever, then we can go through all the different equations, all the different geometry, algebra, whatever else you have, and come right down to the decimal point or what you need." "Maybe you won’t have to figure it out. Maybe you could use a calculator or computer, use some other source to try to help you achieve your goal as far a solving your problem. You could use another kind of tool or an unconventional method." "That’s when [you] sit down and you think about how you’re gonna do this. Are you gonna add it up? If it’s too big to add up by your hands or pen, you gotta get out a computer or calculator or whatever." "I use measurements in our cooking classes every day. You have to know how many tablespoons are in a gallon, how many teaspoons are in a tablespoon. If he give you six gallons, you gotta know
how many quarts. You can use a calculator if you want, but you have to know the formula. If the teacher gives you a recipe, you have to make a decision if you are gonna convert it down to a smaller amount. If you have a cake mix, you have to decide if it's cheaper to make it from scratch." The learners' comments above, along with those of other learners, instructors, and stakeholders, point out that the process of problem-solving involved a variety of strategies.

The use of calculators came up fairly often in discussions around problem-solving. One stakeholder offered his insight into the use of calculators: "Just to be able to use the calculator, to me you're doing a form of problem-solving to know how to manipulate the numbers."

Learners often had strong opinions about the use of calculators as a tool for solving problems. Some felt calculators were a useful tool and could be used to access information in order to solve problems and make decisions. "I just want to make a comment about calculators: math is my hardest subject. I don't trust my own adding and subtracting math. With a calculator you press certain buttons and you know you're going to get the correct answer." "Let us bring in calculators to help us know how to use the calculator with the problem. We should all learn how to write down the problem first." "You need calculators to keep up with the pace of life."

Other learners, however, felt that calculators should not be used. "Take away computers. Everybody relies on the calculator and computers and they can't figure out anything without them. So I think you ought to get back to basics to make sure people do understand instead of 'push this button'. " [Response by another learner] "I agree. I've seen too many times when people just type in a bunch of numbers, hit "enter" and whatever the computer prints out, this must be the truth because the printer just printed it out. They may have typed in a wrong number or one of the formulas may have been programmed wrong. You have a wrong number and people don't take the time to work through by hand to make sure it's right." "I think a lot of people have gotten lazy. They don't do it in their heads; [they] use a calculator. "I got four kids. If they can't do it [math] on paper, I'm sure not buying them a calculator."

One of the five competencies spelled out in the SCANS Report is "Technology". Employees, in order to be successful on the job, need to be able to select the appropriate technology and apply technology to different tasks.

Problem-solving and decision-making often involve teamwork. On the job and in daily situations at home, problems are solved and decisions made with the advice and input of others. While in school situations teamwork is not often encouraged, at work, at home, and in the community, individuals must work together to solve problems and move forward. According to SCANS [pp. xvii-xix], "More and more, work involves listening carefully to clients and co-workers and clearly articulating one's own point of
view. Today's worker has to listen and speak well enough to explain schedules and procedures, communicate with customers, work in teams, understand customer concerns, describe complex systems and procedures, probe for hidden meanings, teach others, and solve problems."

Parents, workers, and community members use problem-solving and reasoning to reach decisions. "Problem-solving for me would be something on the floor that we make, you know by using one of my ... like a caliper to measure it and if it is over by so much, you know you fix it. I send my part somewhere and they have problems with it, saying your gauges, you know this part won't screw into this part. You know it's got to be fixed so that would be problem-solving."

Being able to problem-solve successfully in the workplace gives workers more confidence, which, in turn, gives them more of a voice. "In the manufacturing area, I was 20 years old and three top managers couldn't figure out an algebraic formula and one of them very jokingly said, 'Here, see if you can solve this,' as they all laughed at the thought. However, in one minute, I solved the problem to determine their daily production which they couldn't do."

Adults use problem-solving strategies as parents to "survive". They need to maintain budgets and comparison shop. "When I was married, my wife was smart, so she took care of the bills. When I got divorced I took my boys. I was off work for a year and a half, plus I had bad debt for credit cards. Made $6 an hour with two kids. Had to feed them and pay some on my bills. So basically, I'd figure out how much food we'd need for the week and how much gas it took to get to work and pay for that first. Then I'd pay some on the bills. When the kids needed clothes that came first with the food and gas. I didn't have a checking, savings account. I can't spell or do math. I'm really crappy with numbers, I always get them turned around so I have almost always just paid cash for everything." "I had $45. The decision I had to make was to buy shoes or buy meat and put the shoes on hold. I came to the decision by telling myself that my feet weren't dragging on the ground but with no food, my children and I would've had growling stomachs. I used addition to decide how many packs of meat I could get with my $45."

Adults also use problem-solving strategies to better understand how their money is manipulated. They feel that understanding what is REALLY happening with their out-go will help them better budget in order to create the best environment for their families. "I bought a house last year. The price of the house sounds pretty inexpensive, but when you add up the interest on it ... the points they charge you, the closing fees, the maintenance ... it's like on a 30-year loan, you end up paying three times as much as the house is worth ... You gotta compute simple interest, compounded interest, all that sort of stuff ... First I took what I made a month. I took an average, then I deducted all my expenses, then I had a budget saying what I could afford to pay a month ... simple math ... only you divide that if you have a roommate or whatever ... just basic plan-
ning and basic math skills . . . averages . . . When they first tell you, just put down 5% or 10%, then pay this much a month, you take it like that and you don't know what it really costs you. You gotta figure everything else. That's what math does, it makes you organize, makes you think in a certain manner."

Adults, in their role as citizens, have to solve problems and make decisions using numbers. "Even when you are dealing with your bills, when you are looking in your checkbook, if you have two bills then one of them is going to be late. You have to decide which one you want to pay first. Like for instance, we had a phone bill and a credit card bill and one was going on late and you don't know which one. You got to make a decision between the two of them based on how much money each one is, how much you got in the bank and how much money it gives you to spend for the rest of the week."

(Response by another adult learner) "You can always let your phone bill go because they don't charge you nothing." "Sometimes you have to do the math when you go to buy something. Like you have to ask yourself, like how much you gonna pay for this, if you can afford it or not. If you say like when you buy the furniture, or maybe car, or maybe even TV or something like that, you have to pay like a month. Especially like with the car, you have to know how much you gonna pay every month, how much interest is gonna be on it, how much tax you gonna pay for that car, and you have to add everything on it. If you say how much you gonna pay on insurance . . . say like $2000 for the car, like $100, if you are a young male, so it's gonna be $300. How much you gonna spend for gas, if any problem happens, say like anything broken, if there is no guarantee on it, how much you gonna pay for that. How you gonna afford that car or not. The numbers are very important, if you can afford the car but you cannot afford the repair, that means you don't have the car. If you cannot afford the insurance, that means you gonna have a problem one day with that. Like everything, like furniture, you have to remember if any problem happens, say like if you ... the job, you gonna afford these things after that? The owner is gonna ask you to bring it back, he needs his money in about a month; he gonna ask you in a specific time, so you have to prepare for any problems that happen in the future."

Another example of using math as a community member is this learner's experience working with children at a town gathering: "Well, you use it [math] when you to Town Meeting with different groups to raise funds. I've gone there to help 6th graders raise funds to go on their Great Adventure. They sell coffee, hot dogs, that type of thing right during Town Meeting. They buy a cup of coffee off a kid, a hot dog, a lot of different things like that. The kids each brought in so much of everything. They had to figure out so many people in town, and how many hot dogs they were going to need for that and how much bread. Then they had to decide who was going to work what shift. But, of course, you would have to figure out to make sure they figured it out right. And you had to make sure there was enough people on each shift because Town Meeting ran all day. We started out with a certain amount of money. The two kids, when they finished a shift, had to check and then report to the next shift exactly how much they had."
Implications for Learning and Teaching

Embed math content skills in processes like problem solving, reasoning, and decision making. Processes such as problem-solving are viewed as more than just a topic to be covered in an adult education classroom. According to one instructor, "How can anyone function if they can not solve problems? This is more than just the word problems in a book. This is the real understanding of a work problem or a community problem that needs to be solved. Making mathematics real, not pseudo-real, is important." Other instructors echoed the same philosophy: "Students should be able to apply problem-solving skills including mathematical modeling to solve problems found in life situations." "Good to do 'projects' like floor plans that have interest, life value, and problem solving all rolled into one." "Teach math in a meaningful context of relevant problems, and recognize basic skills and problem-solving skills as mutually reinforcing, and therefore, encourage students to identify or frame and solve problems themselves."

A manager shared what one company is doing to integrate math and thinking skills: "When I look at Motorola most of the training that is going on now is around problem-solving and something like that and the math is embedded in the material. The people don't even know they are teaching math. You know the anxiety that comes with a math class is less and they come through with the actual application."

Integrate reasoning and problem-solving in all teaching. Even when teaching basic skills, such as reading, writing, and math, higher level thinking skills such as reasoning, problem-solving, and decision-making should be incorporated into the lessons. According to SCANS (p. 27): "Proposing an effective menu requires creativity and mental visualization. Learning how to use a spreadsheet program -- by definition -- cannot be accomplished without knowing how to learn. Recommending equipment requires decision making. Developing a training plan that does not upset production schedules requires problem-solving and reasoning skills."

One stakeholder offered her philosophy of the higher level skills: "On one hand we all agree that people should learn to problem solve, reason, communicate, etc. These might be called process skills and all adults (kids, too) do these all the time; we all strive to improve in these areas, whether or not we are in adult ed classes. Indeed, these skills are not particularly mathematical skills, rather skills that cover all domains. On the other hand, a person needs meaningful information and knowledge to be able to solve problems, reason about, and have something to communicate. Therefore, I guess I see these process skills as the goals of all education and learning no matter what the domain. To me, our challenge here is to prioritize the 'specific mathematical content' that is necessary and useful to support the kinds of reasoning, problem solving and communicating that people need to do at the end of the 20th century."
SCANS suggests, "Reading and mathematics become less abstract and more concrete when they are embedded in one or more of the competencies; that is, when the learning is 'situated' in a systems or a technological problem. When skills are taught in the context of the competencies, students will learn the skill more rapidly and will be more likely to apply it in real situations." "Choosing between teaching the foundation and the competencies is false; students usually become more proficient faster if they learn both simultaneously. In sum, learning in order 'to know' must never be separated from learning in order 'to do'. Knowledge and its uses belong together." (SCANS, p. 20)

Provide opportunities for learners to work in groups. Learners do learn from one another, as they have readily testified: "Group work is helpful. A lot of times you get the way other people think." "I really like the math class. All of you are so helpful. We all learn so well together." "If you get into a class where you have more people in the same situations as you are, you seem to learn a little bit more. You sort of feed off each other. Somebody else comes up with an idea that you're having trouble with. You can sort of learn from that. I find that really troubled groups together or really quick groups together works a little bit easier for me."

Working together in groups also gives learners opportunities to hone their personal qualities, an important part of the Foundation Skills (SCANS, page xviii): "Personal qualities: Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty." Not only is interaction with others a key foundation skill according to SCANS, but it is also one of the five major competencies needed in today's workplace. The SCANS Report considers Interpersonal Skills to be key for employees to succeed. "Interpersonal skills. Competent employees are skilled team members and teachers of new workers; they serve clients directly and persuade co-workers either individually or in groups; they negotiate with others to solve problems or reach decisions; they work comfortably with colleagues from diverse backgrounds; and they responsibly challenge existing procedures and policies."

Skills such as those listed above are not developed overnight, nor are they simply "picked up". Learners need to interact with their peers in problem-solving teams within the classroom environment. Adult learners need to work in group situations in order to learn to check reasoning and take advice and suggestions from others. According to The Massachusetts ABE Math Standards, "Genuine respect and support of each other's ideas is essential for learners to be able to explain and justify their thinking and to be able to understand that how the problem is solved is as important as its answer. In all adult basic education math settings, the development of critical thinking skills is crucial. Statements should be open to question, reaction and elaboration from others." (p. 30)
Connecting to the Four Purposes

Problem-solving and reasoning in math are vehicles for independent action for adults. Adults want to be able to find information, analyze it themselves, and then make reasonable decisions based on the data. Adult learners and stakeholders alike were able to provide specific examples of how they use problem-solving and reasoning to make decisions in their roles as parents, workers, and citizens. This adult learner's problem-solving enabled him to make a realistic decision about whether to rent an apartment or not: "A couple weeks ago, I was looking at an apartment. It was one right near my house. I compared how much he wanted for a month, plus all the utilities and add in the security deposit. I compared it to my income and found that I would have about 50 cents at the end of each month to live on. So I just decided not to rent it. I used addition and subtraction and all that good simple stuff."

Problem-solving and reasoning in math are needed for access and orientation. Without these critical thinking skills, it is difficult for adults to sort through the myriad of information surrounding them and make sense of which pieces of information they need to make decisions. For example, listen to this learner talk about all the information that he has to work through in order to determine where he is credit-wise: "If you get a certain percentage of interest from the bank, which is 3% or 4%, you could put it in a long-term mutual fund or CD, you get this much. If you have bills, you pay 20% interest. Is it better to pay off the bills and not save anything, or is it better to save the money? You think, what's the prime rate or the interest rate. You need math every day to survive. I mean when they say they're gonna hike up your phone bill so much percentage points or you get a refund from the water company for this much; I think it's all based on numbers." And this learner explained how he gathered his information before making decisions about a family vacation: "I'm leaving Saturday, going to Florida, so I called every airlines to get the cheapest rates to Florida and then I did the same thing with the hotels. Then I'm taking my two grandkids with me so I had to multiply by three."
COMMUNICATION

Math for me is the same as for W. I grew up with math and numbers. Raised in the South, being poor, we had a love for money, a need for money, so it was kind of natural. When I became older, math became like a second language. I relate to it like a second language. It's automatic. I've never had difficulty in math or anything pertaining to numbers. I've always loved it. I've always found great success and accomplishments dealing with math and numbers.

Overview

As the learner quoted above affirms, math is a language. Mathematical communication is an overarching process which includes understanding, expressing and conveying ideas mathematically in order to reflect on and clarify one's thinking, to make convincing arguments, and to reach decisions. As noted in What Work Requires of Schools, a SCANS Report for America 2000, arithmetic and mathematics are essential basic skills and part of the foundation each worker needs to be successful. Effective workers must be able to "interpret and communicate information" and "communicate ideas to justify positions". In the workplace, much of this information and many of these ideas are mathematical.

Mathematical communication can occur in any relationship and context. In the ABE setting, communication happens among learners and between learners and their teachers; at work among workers and between workers and their supervisors; at home among family members and between children and their parents; and in the community among individuals and between community members and public officials. Good mathematical communication is like all other effective communication requiring listening, speaking, reading and writing skills along with interpersonal skills.

The adult learners who participated in the ANPN Focus Groups were asked to prioritize different mathematical topics; they rated communication as the most important area. Stakeholders representing public and private employers, K-12 and higher education practitioners and administrators, professional development providers, ABE math teachers, workforce development officials, educational publishers, and researchers and other academicians also included communication among their top four priorities. (Please see the appendices for further information.)

Key Findings

First and foremost, communication is essential for understanding. As stated by learners, "We need communication so that we can understand and be understood;" "You have to communicate in order to listen and understand with somebody else;" "We
looked at communication as being the very basic, the very foundation;" and "Communication because it's the first thing you have to understand. If you don't understand the problem, if you don't understand the words ... then you really can't solve anything."

**Communication provides the foundation for learning** in school and in life. "If you can't communicate, you can't learn." "So we thought communication was very important in being able to understand and making progress in learning basic skills, being able to understand the other things on the list (other math topics)." "Without the communication of math--no teaching or learning happens."

**Communication includes knowing when and being able to ask for help** in the ABE math classroom and in life in general. As stated by learners, "First is communication. Let's say you're going into math ignorant. You gotta be able to communicate or to get you a grasp on the other stuff. If you don't know how to talk and ask for help, you'll never get nowhere." "People can go through life not asking for help and they never get nowhere. You can't just expect everybody goes into a situation knowing something about it. They're gonna have to communicate. They have to get some help from others."

**Communication, in math as in other aspects of life, is the bridge to finding and exchanging ideas, to identifying problems, and to seeking and finding solutions to these problems.** "Communication--we felt it necessary in being able to do reasoning, to discuss with others, to help identify problems ..." "We didn't think there could be any exchange of ideas if we couldn't communicate." "To me this is the bridge—communication. If you can't articulate how you got to where you're at or what it means ..." "Basically you need communication to come up with new and better ideas."

**Communication is essential to working collaboratively at home, in school, at work and in the community.** "You need communication to get along with one another." While some learners and stakeholders focused on the relationship between learners and teachers, others talked about communication across all aspects of their lives. "We picked communication first because you have to communicate with the teacher and, like I said before, I tell the teacher what I don't know so she can work with me helping me understand what I don't know." And "The teacher has got to get through to you." But also: "Without communication, you can't do anything." "You have to communicate with one another to solve problems." "We based ours on everyday life. Communication is the key." "...being able to talk openly about and convince somebody else ..." "Communication—a chance to come together, present opinions, organize ideas."

**Communication is the link that makes other math skills effective.** As one stakeholder notes, "The other big piece that we do is that it's fine and dandy to do all this math but then you had better be able to communicate what you've just done to some-
When asked to give examples of decisions involving math and to think about the math skills they use as family members, workers and citizens, both learners and other stakeholders articulated examples of work, family and consumer-related situations in which mathematical communication skills are important. For example, talking about buying/selling a house, one learner states, "... communication is very important. You know, say for instance, you are working on a mortgage company, and then you're communicating with other salespersons which is selling the house and then they told you, well it is this much rate and you look in the papers and it is a different percentage rate on that. And so you communicated with the real estate person. Sometimes they want you to pay all the points for the house and you say, 'Why don't we pay half and half? Half to the seller and half to the buyer.' And that is communication." And another learner responds, "Because if you don't communicate with the people wherever you go, whatever you buy, you don't do it. You have to communicate with everybody."

Mathematical communication is also important within the family. "You know, the parent who can explain to the child why there isn't the extra money for the pair of Nike tennis shoes that cost $150 a pair. They need to learn a little bit about budgeting. And so putting that in communication, putting some of that together with the other basic skills." (stakeholder)

Talking about work, another stakeholder states, "Consider, for example, that people's ability to understand and communicate about (rather than compute) what an average or percent is, understand notions of sampling and representation, make sense of and make choices about probability and risk (e.g., likelihood of accidents, errors out of xxx products), and anything that is decreasing, increasing, or changing its magnitude ..."

Mathematical communication—the representation of a problem in mathematical language—also happens in the "other" direction, especially as individuals interact with technology. As explained by a teacher who participated in the "Virtual" Study Group, "But beyond this, as technology becomes more pervasive, it is necessary for one to be able to distill the elements of a real situation into a mathematical expression—the universal language, if you will. In order to communicate the problem to any one of our technological aids, it first must be translated to symbols and then the results from the machine must be interpreted in light of the situation. (Reminds me of the fact that although the new dishwashers can scrub the pots and leave the glassware gleaming, they cannot load or unload themselves.) I believe it was M. who made the suggestion that from the beginning of the discussion of percent, symbols representing the words, concepts, and operations could be included."
Implications for Teaching and Learning

Increase the focus on mathematical communication. Teaching mathematical communication is integral to the success of math reform efforts, and both learners and stakeholders recognize the need to increase the focus on mathematical communication within the ABE setting. For example, one learner states, "More materials and better communication. More work and more materials one-on-one, verbal explanation, groups, slides, visual effects. You know, different ways that everybody can understand, different ways. If you don't understand the problem, you need to go to someone else to communicate the problem in other ways. A lot of people, they don't know how to read, so maybe pictures. Yeah, that makes it interesting."

Another learner, recognizing that talking about math has increased her comfort with math states, "I would like the opportunity to do like we're doing today, sitting here in a circle and discussing math. The more you can talk about something in a group, the more comfortable you become. Then it becomes more like other classes I have that I like. I never thought math had anything to offer me. It just seemed like a teacher up there at the board, with lots of subjects that weren't relevant to me, and there's no interaction. To be able to relax and learn that math is just like any other class."

Stakeholders also recognize that communication is key. "Most ABE/GED classes, because of their rolling enrollment, are taught on an individualized basis. In order to function in the 21st century, our students need to communicate mathematical ideas and use them to solve non-traditional problems. To accomplish that we need classrooms where discussion is a key part of instruction."

And, "I agree with much of what P. said. Open-entry, open-exit individualized instruction may not be the culprit, however. Students always working by themselves with no requirements that they communicate their problem solutions to anyone else might be. Pairings and small group work seem viable alternatives to whole-class instruction when it is difficult to find many students attending regularly and learning at the same rate." And "Use a variety of approaches, models and manipulatives and have the students involved in talking about their work with each other on a frequent and regular basis."

Encourage good mathematical communication for work, home and community situations through group discussions. As noted by one teacher, "Good communication. Math should be taught using a well-defined vocabulary of math terms so that what the teacher believes is being taught is what is being received by the student. This should involve verbal and written feedback from the students to confirm that they understand and can express to others what they know. As a skill necessary for future employees, students should be able to express mathematical ideas and concepts orally and in writing. Also very few employees will work totally by themselves. More and
more, work will involve listening carefully to clients and co-workers and clearly articulating one’s point of view."

Connecting to the Four Purposes

Mathematical communication mirrors the four purposes of literacy identified by learners in *Equipped for the Future*. Mathematical literacy, or numeracy, being able to understand, interpret and express ideas mathematically, is important for **access and orientation**. Being able to communicate mathematically to others what one thinks and feels is math as **voice** and numeracy is a vehicle for **independent and collective action**. And, finally, the ability to communicate mathematically is one, primary **bridge to the future**.
NUMBER AND NUMBER SENSE

"Workers can't be afraid of numbers!"
GM Parts Plant Manager

Overview

Being able to handle numbers comfortably and competently is important to adults as parents, workers and community members. This competence relies upon having developed a kind of "number sense" about whole numbers, money, fractions, decimals, and percentages. Number sense includes calculation skills with numbers as well as a sense of number and operation and an ability to appropriately use estimation, mental math, computation, calculators or other tools. The learners, teachers and employers that were in the ANPN focus groups had lots of opinions about NUMBER. Learners ranked whole numbers, estimation, and fractions/decimals high as important math topics (3rd, 4th, and 6th); stakeholders concurred, ranking whole numbers fifth and estimation fourth. (Please see the appendices for more information.)

Key Findings

Whole number computational skills are necessary but not sufficient. "If you don't know whole numbers, that is the basis that everything else is built upon... I mean how can you do any other type of thing if you can't do the simple whole number computations? ... Right there you're starting with one foot in the hole..." "I think whole number computation is most important... it's a basic fundamental thing. For example, there is a tree. If the root is weak, the tree's life will not be long. So we have to know whole number computation first, because it's basic, the root of the tree."

The adult learners quoted above share a belief held by learners, educators and employers alike about how important it is for adults to be solidly grounded in whole numbers. What should be included in the root of that tree? What's the nature of a good solid understanding of number?

The Massachusetts ABE Math Standards states: "To be efficient workers or consumers in today's world, adults must have a strongly developed conceptual understanding of arithmetic operations as well as procedural knowledge of computation and number facts. They must be able to perceive the idea of place value and be able to read, write and represent whole numbers and numerical relationships in a wide variety of ways. Simple paper and pencil computation skills are not enough. Adults must be able to make decisions regarding the best method of computation (mental math, paper-and-pencil, calculator/computer) to use for a particular situation." (p. 38)
But even deeper in the root of the tree, are some very basic understandings such as sorting and classifying, comparing, ordering, counting and pattern recognition and development. These "pre-number and pre-operational" understandings apply to all numbers. One adult education math teacher reflected on how important it is to be able to do those "pre-number things with fractions before one can make sense of the operations."

Other math educators included among the number/number sense basics:

Operation sense or understanding how the four operations (addition, subtraction, multiplication and division) work means "recognizing conditions in real-world situations that indicate that the operation would be useful in those situations." *(NCTM, 1989)*

"Multiplicative reasoning is basic as it leads to the understanding of multiplication, division, and proportional reasoning. The notion of 'unitizing' or forming 'units of units' where a person begins to group objects together and consider them as sets or wholes, e.g., five candies per bag, six bags, gives 30 candies. The five candies are considered a unit." (teacher)

Proportional reasoning was mentioned as critical to "people's ability to understand and communicate about (rather than compute) what an average or percent is... Anything that is decreasing/increasing or changing magnitude relies heavily on deep understanding of proportions, rates, ratios, relations and relative comparisons." (stakeholder)

All these elements add to a dynamic definition of what learners, employers and teachers mean by being able "to do whole numbers."

**Estimation and mental math are essential to sense making with numbers.** ANPN focus group members emphasized how critical the skill of estimation was. One employer said: "I realize in the last few years in my career path, I use estimation so much more now than I ever knew (I would)....you discuss something on the phone and 'How much will I get paid for this and that?' I can do a quick estimation, you know. 'It is going to be about a thousand dollars commission here.' Just being able to do that -- I probably do estimation 80% of the time and there is 20% of the time when I actually need to figure out a shipping charge or whatever. But most of the time in dealing with all my sales reps and customer in general, most of the time, it is like estimating 90% of the time -- giving them a ballpark figure and they are comfortable with that. I've actually had an awakening with estimation in the last couple of years. I didn't realize I was using it all the time. Yet someone right next to me says: 'How did you know that, how did you figure that out?' Obviously, I've learned the process because I practice the process."
The SCANS Report suggests that work competencies and skills require estimation. Workers need to be able to "summarize information, set upper and lower limits and estimate if it falls within acceptable range, understand precision both as consumer and producer, estimate time and costs, troubleshoot and anticipate consequences." (p. )

And the teachers who wrote The Massachusetts ABE Math Standards concurred. "Estimation is probably the most used and useful skill for adults and continually plays an important role in the adult learner's life. Adults use informal measurements in activities such as cooking, shopping, buying clothes or estimating the time required for daily tasks. Good estimators use a variety of strategies and techniques for computational estimation..." (p. 35)

Adults use estimation everyday and all the time; it's woven into the fabric of daily decision making. "Having $50 to use at the store and seeing how far I can stretch it. I kind of round the amounts off and keep a running total in my head till I think I'm out of money." Adults use estimation to predict and to plan. "If you are going to the store you usually estimate whether you can afford that coat or not and how much it would be and how much off and then reason, making conclusions based on that estimation." And they use it to check outcomes. "Does this make sense?" Approximations guide thinking all along the way. It is a kind of sense making activity. In the final analysis, people need to be able to decide how precise they need to be in a particular situation.

Fractions, decimals, percentages and ratios are necessary and challenging. Learners, educators and employers are clear about the need to understand and use decimals, fractions and percentages. "It's never just whole numbers... it's always fractional amounts and decimals." "Nurses using measurements and fractions to give the right amount of medicine." Many also thought that adults should be comfortable handling numbers in a variety of forms. One teacher cited "understanding number relationships, about how percents and decimals and fractions are related" as essential.

This is supported by The Massachusetts ABE Math Standards which state that adults should "understand, represent and use numbers in a variety of equivalent forms (integers, fractions, decimal, percent, exponential, and scientific notation) in real-world, work-related and mathematical problem situations." (p. 41)

Fractions were frequently mentioned as a hard topic in school math, both in childhood and in adult education classes. "Fractions, decimals and percents have always been really hard to do." "Math was OK until seventh grade when we started fractions." "When I was in school and we started on decimals and fractions, I could not catch on and my teachers wouldn't help so I got behind in class and couldn't keep up with everyone else so I just gave up completely on all of school so that no one knew that I couldn't do it and quit school..." "I never understood how to work problems like $1.23 x 33 1/3. I
missed school when this was being explained. I was never able to learn this throughout school."

Knowledge of numbers is useful to adults in making decisions about issues that relate to their families, communities, and workplaces. No matter what the occupation, employers and employees furnished many examples of how critical number is in their lines of work:

An automotive parts plant manager from New England ticked off aspects of number proficiency needed in his workplace. "The workers are usually on a forklift making some quick calculations such as knowing how many boxes of filters to load if a dealer orders 100 and there are a dozen per box. They also need to be able to read and retain an identification (SKU) number ... to be able to break up a number, repeat it, recognize it and locate it." Finally, he said how important it is for workers to be able to use logic in solving problems in the workplace.

A banker noted the importance of calculators in banking, but was concerned that employees were now doing things that people used to do in their heads, (like adding and doubling), but not using the calculators for more complicated problems. He would like to see more of that.

A restaurant owner, stressing the need for mental math ability, says she noticed over the past ten years, "employees' skills have gotten worse... I've had to change the equipment because people didn't know how to do math. I have to put calculators around the restaurant and change registers. If some item costs $5.25, and you give them a ten and then you say you have a quarter, they're lost and have to start over!"

A learner states, "Everyday at work I use math. I'm a cashier and gas station attendant without a cash register. Therefore I have to figure out change on my own and if people get the wrong change back, they become highly upset and critical. In order to make change at work I usually use (mental) addition, subtraction, and multiplication."

Parents, family members and caregivers had no trouble citing instances where they use number in the daily care and survival of their families. "Just the overall running of the household...checkbooks...there's bills, rent..." They mentioned such things as mixing formulas, dividing candy or toys, how much fun money you get after you estimate the bills, cooking, house expenses, buying cars and houses, grocery shopping, comparing prices, and doing taxes. "When my husband is short on money, he'll claim more deductions on his W4 for a few weeks and then change it back. He has to be really careful - last year he got a little carried away, and we ended up having to pay at the end of the year."
Parents see helping their children "do math" as a key responsibility. Sometimes that means being available to help with homework. "My kids ask me all the time - like a division question or something". Other times it's informal teaching. "Asking the child to spend her own money for some groceries or practical things, so she learns how much things cost." "I use math with snacks with my children. How many crackers the want. How many they have."

Citizens make personal decisions as consumers. "My biggest (math) decision based on money is probably where I'm sitting right here and now. I decided to come back to school... I figured out how much it would cost per quarter, I figured out how much income was already coming in and allotted for other expenditures. I came up with my numbers to see if I could afford to come to school and still be able to maintain the same life style. Or at least maintain a lifestyle! You know to be able to come back to school and cut my hours at work and comparing the numbers... like the percentage on my student loans... how much money I would get from the government, different funding... trying to work at that... plus, still go on vacation. It was everything from simple addition, just adding up what I make each month... figuring out different percentages, what's my loan going to cost each month. It ran the gamut, even figuring out ratio and proportion."

Implications for Teaching and Learning

Teach and learn about numbers in context. The teaching and learning about number (whole numbers, fractions, decimals and percents) must be done in context right from the beginning, because as an adult learner said, "Although whole numbers are nice, they are not the numbers of real life." Neatly controlled pages of decontextualized computation are not the way adults learn best. "My best learning situation is probably work... I got the 'basics' in school, the really simple stuff, that wasn't so great. But I've been working at the same company for 11 years. We're really a big textile distributor, and they run quality control, so it's constantly figuring out, we're running hundreds of pieces. It's different numbers, it's never just whole numbers, it's always fractional amounts and decimals... We get stuff from different people. We need to get so many small pieces running from a linear yard. We have to figure out cuts, how much they can get out of what, so it's just a constant use of it, the sheer volume of doing math. It's just constantly going over stuff that's made me have the decent knowledge that I have."

So many others concurred. "We expect lifelong learning so we should use real-life problems." "Learning how to compute percentages in the context of a real life budget problem will be much more profitable than if taught in the abstract or with artificial word problems."

The SCANS Report insists that "the most effective way of teaching skills is 'in context.' Placing learning objectives within real environments is better than insisting that students first learn in the abstract what they will be expected to apply... Students do not need to
learn basic skills before they learn problem-solving skills. The two go together. They are not sequential but mutually reinforcing." "Real know-how -- foundation and competencies -- cannot be taught in isolation; students need practice in the application of these skills." (p. 19)

*The Massachusetts ABE Math Standards* holds that "computation skills should be practiced in the context of problem solving and not as a set of isolated skills. Adults should be encouraged to develop and share their own tricks and ways of computing percentages; for example, sharing short-cuts to determining the tip on a meal tab or finding a discount." (p. 40)

**Build upon adult's personal number sense.** Traditional "school math" calculation methods are not always useful. One of the teacher/authors of *The Massachusetts ABE Math Standards* related this happening:

"I asked a group of my GED math students to tell me how much it would cost if you bought four shirts for $7.98 each. They were told they could figure it out any way they wanted, except they could not use paper and pencil. I watched as they used their fingers in the air or "wrote " on the desk. Most we're able to multiply and get the right answer. When I asked HOW they got their answer, all agreed they needed to multiply $7.98 by four."

"I then asked if they were in a store and had to figure out the same problem would they have done it the same way. All agreed they probably would NOT solve it the same way in 'real life.' Some said they would have multiplied four by seven plus four by one and then subtracted eight cents from that total. Others said they would have rounded $7.98 to $8.00, multiplied that by four and then subtracted $.08 for the product. I then asked why no one admitted to solving the problem like that in class. The response was this is math class so they needed to do it out." (vol. 2, p. 60-61)

This notion that adults should do it the "right way" or the teacher's way robs adults of their mathematical power. Good numeracy instruction must build upon an adult's personal number sense and help further develop that sense so that he or she can handle real life situations.

Adult educators must question the teaching of "school math" especially when those strategies or techniques are rarely utilized by other competent adults. The way estimation, for example, is taught has nothing to do with the way people really use it in the workplace. The choice of teaching complicated fraction computation which will never be used in real life must be weighed against more important and realistic skills.
Connecting to the Four Purposes

It is easy to see how number sense is connected to each of the four purposes for literacy. Number sense enables adults to be able to interpret (access) and represent (give voice to) the world in which they work and live. Good number sense supports the judgements and decisions that lead to independent action. "Number sense is the cornerstone of mathematics ... It is exemplified every day, whether we consider notions as complex as the consumer price index, as pivotal as the impact of the Great Depression on United States history, or as personal as a blood pressure reading." (The Massachusetts Mathematics Curriculum Framework, p. 32)
In the workplace the common thing would be -- we measure everything. If someone is measuring something and they are taking samples and they see that it is going out of the acceptable margin. I mean, they need to be able to stop everything and get someone to find out what is happening. Upper and lower limits, check that against a blueprint and see that the upper and lower limits have been put in properly, then compare that with how it was running earlier that day. Someone has got to understand; it could be a supervisory level. Someone's got to be putting in the data properly. It is computerized, of course, but it is only as good as the information that someone is putting in. We try to tell people, numbers have got to make sense. They have got to make sense. You have to be able to see if for twenty-five days it has been operating like this and suddenly it looks like this. What does your gut tell you? There is something wrong here. Something is going out, that kind of thing. Look at the chart. People should have enough understanding and knowledge to read all the results of all our quality measure that we post on a regular basis. And if they see something that they don't understand, they need to question that. Say, 'what is that?' How does that impact that? Where does that come from? Everyone of those things impacts something else. In a workplace setting, there is this domino effect. Everything builds on the next thing. From the time that raw material comes in the door and one process after another through departments takes place. You are adding value, but you are also adding costs. We need to catch those numbers if they start to go out of alignment. Again going back to -- people need to see the big picture first. The numbers stand out, how things operate. So they see the big math picture. You get to the big math picture through all these tiny calculations.

Overview

Adults make decisions based on data in their daily lives and in the workplace. According to Equipped for the Future, "Adults are also interested in learning and strengthening the skills associated with using information to have an impact on the world. They identify the need to develop the problem solving and critical thinking skills that have to do with analyzing and reflecting on information in order to make good decisions..." (p. 24) Reading charts and graphs, interpreting the data, and making decisions based on the information are key skills to being a successful worker and an informed citizen. Being an informed citizen includes understanding statistics and probability as well. Adults
cannot make reasonable decisions unless they understand from where the statistics come.

Charts and graphs are essential in the workplace. According to SCANS documentation, tomorrow's workers must have reading skills that enable employees "to read well enough to understand and interpret diagrams, directories, correspondence, manuals, records, charts, graphs, tables, and specifications. Without the ability to read a diverse set of materials, workers cannot locate the descriptive and quantitative information needed to make decisions or to recommend courses of action." (p. xvi)

Data from charts and graphs are used to make decisions. Graphs are useful tools in that they organize data so that information becomes clearer. This organized information can then be used to draw conclusions, to make decisions, or to influence others. Data is organized in a variety of fashions, from charts and graphs, to computer-generated spreadsheets.

In comparing the comments made by stakeholders — often individuals in managerial positions — with those made by adult learners, several interesting distinctions were noted. Stakeholders tended to use the data in charts and graphs to make inferences and decisions. Adult learners, on the other hand, were more inclined to use charts and graphs in a more literal way - simply to gather information. Adult learners who created charts and graphs used them to help themselves while stakeholders (management) used charts and graphs to influence others. In addition, adult learners claimed either to not have a use for charts and graphs or felt they used them when they needed information. Stakeholders shared a concern for the lack of "chart literacy".

**Key Findings**

**Data collection, analysis, and graphing are essential in the workplace.** SCANS proposes five competencies needed by employees for success in the workplace. The competency Information clearly suggests that data analysis and graphing are necessary skills for tomorrow's employees. An example of the level of proficiency for the competency Information includes the ability to "... analyze statistical control charts to monitor error rate. Develop, with other team members, a way to bring performance in production line up to that of best practice in competing plants." (p. xx)

Many industries, manufacturing in particular, now use statistical control processes (SPC) to monitor their processes in order to ensure quality products. Often the frontline employee is required to collect the data used for charting the manufacturing process; therefore, employees at all levels should be knowledgeable about and comfortable with using a variety of charts. As more and more quality teams -- consisting of a variety of employees -- are charged with the task of ensuring quality products, employees will need to have an understanding of probability and sampling. During a focus
group session, when asked how math is used in the workplace, an adult learner responded, "Sometimes I have SPC graphs. It kind of determines if something is wrong with the machine and pretty simple things, nothing really major. One out of 6 is bad, shut the machine down. A lot of times we don't count the parts. They'll just be in a can and we write down on an overlay. You know, if you red tag some parts that are no good, you tag -- nothing really major."

It is interesting to note that only stakeholders seem to be acutely aware of the need to have the ability to read and interpret statistical process control charts. "There are two other areas and we mentioned this before about statistical process control. Our industry is moving into really using numbers to determine whether the production process is functioning or not. And they are using the concept of time as well as numbers. How fast it takes to do a particular process. Budgetary hourly rates is another phrase that is kicked around..." Yet another stakeholder commented, "In the workplace today, employers want everyone to understand quality. Any chart or graph that shows production uses statistics."

Other forms of charting are also used in the workplace to make decisions as well as gauge accuracy. One learner shared how he uses blueprints to determine whether a part is within tolerance: "Basically at work every day, you know, just looking at parts, I use a blueprint. That gives you a tolerance, a couple thousandths here, couple thousandths there, sometimes 5, -2, and if you've got a part that's right on the borderline of tolerance you want to decide if you want to just keep on running it or fix it or basically see what kind of problem it is going to cause." And another adult learner has an idea of what will be required of her in the workplace: "For myself, I'm hoping to get into social work. So I need to be able to read and understand graphs (for statistics). That way, I'll be able to compare past trends with current trends and hopefully predict results. Also making my own graphs. At least I think that's what statistics will be like."

**Statistical knowledge is important in problem-solving and decision-making.** Adults, often without even realizing it, make decisions based on statistical information. It may be via the television, radio, or it may be through print materials. The following adult learner made her decision based on what she had seen in a magazine. "That reminds me of a fee that I thought was too high. There was a newsletter I wanted to subscribe to, but it charged $35 a year, and I couldn't understand why a little paper would cost so much. But then on the inside it showed a circle graph, with sections like a pie, and it showed what the money was spent for. Then I could see that it really was a reasonable amount to pay." It is important that adults know that they are using statistical information in their reasoning. A stakeholder weighed statistical information to decide whether it was relevant to him: "I was reading an article about what to look for if a kid is using drugs. And I thought about my 14-year old grandson and how different it is now that he is a teenager. I had to take my random knowledge of a person and decide whether it was statistically relevant to drug use." Another stakeholder agreed that sta-
tistical information does influence decision-making. "You're seeing different information that you need to reason and draw conclusions based on this. Is this a good sale, not a good sale, and so forth depends on the whole reasoning process -- looking at graphs and charts -- looking at your paycheck and whatever -- just being presented with information and attempting to draw conclusions."

Statistical information is used to communicate information and sometimes influence others. Understanding the flood of statistical information allows adults to make more informed decisions. A teacher said it very well, "[When] we understand math, we can use it to take control of our lives. Do our own figures so as not to be the victim of scams." A stakeholder explained how she thought a nice graph could be an influencing agent: ". . . Not only did he do nice histograms and circle graphs but inside he did it by ethnic, by cities that the students are from, and so forth, and then he has a final chart on the money that he's asking on the back. I think it is a nice piece of work. On the back is a financial chart which could hopefully affect the budget."

**Graphs, tables, and statistics make data easier to understand.** Adults create graphs for clarity and understanding, for themselves as well as for others. Sometimes seeing the data in chart form makes the decision making process easier since the information is clearer. The following adult learner provides an example of how charts helped them see the issues more clearly. "When I bought my car, I put a $1000 down payment on it. I owed them like $8000 on it for five years which I was gonna end up paying a lot of interest . . . so I made a plan to pay as soon as possible so I save the interest. So I figured out how much I could spare each month. I did a budget so I would send them like 2 payments, 3 payments a month. I did a graph to see how far it would go. So like in a year and two months I called the company and I asked them how much money I save from all the interest from me paying early and I end up with almost $2000 and I ask them if I can take this $2000 I saved and add it to what I pay and they said I could."

Even when the charts and graphs are not initiated by adults, they do tend to make the information easier to digest. From an adult learner, "I watch this thing on PBS. It's like this physics show -- and it's actually enjoyable. They give images and graphs; they give you things about different theories with physics. It is hard to understand, but the way they put it on TV, it's very simplified. You can actually see it with your eyes."

There are those, however, who don't agree that charts make understanding information easier. A stakeholder commented, "Right now all the changes that are going on. There's ATM. You can't go to a bank anymore necessarily and talk to a person. Statements are getting more, well, they are supposed to be easier to read . . . things are constantly changing on them, you know."
Charts and graphs are also used for record keeping such as spreadsheets and data bases. According to the SCANS report (p. xviii), employees of the near future will need to be able to use spreadsheet programs for tasks such as monitoring expenditures.

There is a concern for the lack of understanding and ability to read and interpret statistical information, including charts and graphs. There is also worry about the use and misuse of statistical information. While adult learners did not have this concern, stakeholders and instructors agree that adults do tend to have difficulty deciphering what the numbers and charts mean. Stakeholders shared their concerns: "I think transferability is really hard for adults. To know a concept is one thing, but to be able to look at a table and say, 'I understand this table, or I can read this table, or I can interpret what this means' is hard to do." "I tried something in the workforce here about a month ago based on quality where we measure quality based on the number of errors per 1000 lines shipped. We benchmark ourselves against Toyota, Ford, Chrysler, and all the other automotive people. I had a lot of blank stares going back from the audience. They could not associate what I was trying to talk about . . . statistics to the competition. They simply had a block saying, 'But we're different.' Math is math and I was having a hard time with that comparison. They were not able to connect. I kind of lost them on that one. So we are going to try again going back to more graphs I guess is probably the best way to try to communicate this. You know, 'A picture is worth a thousand words.' I'll try that out next time."

Yet another stakeholder believed that understanding statistical data involved much more than just looking at numbers in a literal sense. "I'd like to also suggest that, underlying understanding of statistics and some key aspects of both measurement and number sense lies the fuzzy yet critical domain of 'proportional reasoning.' Consider, for example, that people's ability to understand and communicate about (rather than compute) what an average or percents, understand notions of sampling and representation, make sense of and make choices about probability and risk (e.g., likelihood of accidents, errors out of XXX products), and anything that is decreasing/increasing changes its magnitude, relies heavily (though of course not exclusively) on deep understanding of proportions, rates, ratios, relations, and relative comparisons, which are all parts of the same conceptual system that mathematicians (and I'm not one of them) call 'Rational number concepts.'"

Adults use charts, graphs, and statistical information in their roles as workers, parents, and citizens. As workers, adults used data to monitor the quality of the products being made. They also make decisions based on the data. A stakeholder uses blueprints and statistical process control charts: "People that I work with have to know at least the basic math skills in order to perform the SPC and we do a lot of blueprint reading -- a lot of math involved in reading a blueprint." A learner explained how he uses a variety of skills to do his job. "My daily job was office manager. My responsibilities were to do a daily cash reconciliation, post accounts receivable, accounts payable,
keep up with hourly employee time cards and keep track of everyone's vacation and sick time. I always made decisions using amounts, money, graphs, and basic addition and subtraction skills. I used all these skills on a daily basis to reconcile and solve any problems regarding my specific job requirements."

As citizens, adults need to understand the data that they are continually being bombarded with -- through all forms of media. This stakeholder clarified the importance of understanding data as it relates to elections. "I want to switch from workplace to community and society and all that data that we get inundated with -- try to make, you know, what's going on in the world -- what does it mean to win a primary and say that is 14 electoral votes and, all of a sudden, you're supposed to be the front runner and how do you gauge the real significance of that. Then the next week you're blown out of the water supposedly because something else happens. I remember the election last year when the polls and the data, they became the driving force themselves as you watched one go up and one go down. How do people really assess that because it is such a big part -- you're talking about one arena, but locally, we're having a school tax referendum. People are being surrounded by numbers in which they've got to make decisions. This was cut in half. Well, what does it mean that this was cut in half? Half of what? Is it really that big of a difference . . . or whatever. So I think something in adult ed. I think we're tending to look at the work stuff a lot and a lot of the sort of consumer needs, but I think some of the data in terms of broader societal issues. We're trying to get people more engaged." And another stakeholder, when asked what were the three most important math concepts that should be taught, included statistics: " . . . As members of a community we use statistics to understand our community better and to help create a better environment for ourselves."

Implications for Teaching and Learning

Introduce more work-related charts and graphs and other statistical information to better prepare adult learners for the world of work. According to the Massachusetts ABE Math Standards [pg. 50], to become successful employees, adult learners need to have the opportunity to "systematically collect, organize and describe data; and construct, read and interpret tables, charts and graphs". Adult learners need much more than simple activities where they are asked to find literal bits of information in charts and graphs. They need opportunities to collect their own data, then create their own charts and graphs. In designing their own charts, adult learners begin to understand how data can be represented. Employees at all levels are being required to read and interpret charts and graphs, so adult learners need to be prepared. As one stakeholder put it, " . . . Being able to be chart literate and being able to read those charts and graphs that we produce and we put up in our plant everywhere; all our quality charts -- the lowest level, entry-level employee should be able to read those."
Provide hands-on experience collecting, organizing, and interpreting data. It is not enough that adult education classes give learners practice in simply reading and finding literal information based on charts and graphs. Providing adult learners with the actual experience of gathering data, deciding on how to represent the data, and interpreting the results will give them a deeper understanding of statistical information. According to The Massachusetts ABE Math Standards (p. 50), adult learners should be able to "make inferences and convincing arguments that are based on data analysis; and evaluate arguments that are based on data analysis." Adult learners need opportunities to interpret charts and graphs and discuss their findings and implications with others. A stakeholder added, "...Need basic level of mathematics to survive, for public discourse -- the use, abuse, and misuse of statistics today -- how and why -- more observation -- reading charts and polls. Why they're done and how they're used."

Connecting to the Four Purposes

Stakeholders interviewed for this project were concerned about many adults' inability to read and interpret statistical information. This suggests that many adults, at least when it comes to statistical information including charts and graphs, need to become more literate for access and information. The National Adult Literacy Survey includes the literacy tasks of reading and interpreting statistical information under the heading of quantitative literacy. In fact, while most adult learners viewed charts and graphs as a medium for accessing information, there were a few exceptions as illustrated by this interaction between three adult learners and the focus group facilitator. BB [facilitator]: "How about if you're reading the paper and you see a graph comparing the number of high school dropouts in 1965 and 1995. Can you read and understand information presented that way?" M [first learner]: "You need to know the number of students in '65 compared to the number of students in '95." C [second learner]: "I can't read graphs, no." BB: "Would it be important to you to be able to?" C: "No." M: "Yes, it would be important. S [third learner]: "It is if you're doing a test." BB: "Any other reason?" S: "No, not really." C: "Yes, actually it would be important to know." S: "My brother-in-law uses his computer to graph his income, you know?" M: "The light bill is a graph."

The creation of charts and graphs based on data collection is one method of giving voice to the data. Literacy as voice requires that adults be able to communicate to others; charts, graphs, statistics are each a means of communicating what the data is suggesting.

As seen in earlier examples, adults use statistical information to guide their decision-making. They often create charts and graphs to clarify the problem, then make decisions based on the interpretation they give. The following adult learner provides an example of how adults use charts and graphs to take action and make decisions: "We had to reduce our hours at work. We made a big chart on the chalkboard. We compared four-hour shifts, eight-and ten-hour ..."
GEOMETRY: SPATIAL SENSE AND MEASUREMENT

I need math when I redid my house, measuring dry wall. That was a problem but we did it. How much did I need? How much to go buy? ... I cut dry wall to remodel my kitchen. When we put it up it didn't fit. It's uneven but most people can't tell.

Overview

As told by the learner quoted above and noted in the Massachusetts ABE Math Standards, "adult learners who attend basic mathematics classes at any level share a wealth of pragmatic experience surrounding geometric and spatial concepts. They've probably built a bookcase, laid out a garden, applied wallpaper or tiled a floor, all the while discovering informally the rules which formally govern the study of geometry itself. For many adult students, geometry is one math topic that immediately makes sense to them and gives them confidence in their ability to learn." (p. 51) It is also true, however, that many adults associate geometry, like algebra, with failure. "In seventh grade I started to have trouble with geometry. I still have trouble with the GED geometry. I don't know why we have to learn it. It's so confusing." And "the hardest part for me is geometry."

Measurement, a foundation skill for geometry, is also an essential life skill, one that adults use in many different but familiar contexts: "on-the-job, for home improvement projects, in the daily task of food preparation." (Massachusetts ABE Math Standards, p. 53) Or as one learner states, "Measuring. You can put it under workplace, family. You're always measuring something. You can be at home or stuff where you're measuring out ingredients, whatever, like cooking."

Key Findings

Measurement is not an end in itself. It is a tool used in many contexts: home, work and community. We measure many different attributes of physical objects and time in many different ways in many different situations and contexts. As learners state, "Measuring, well, cough medicine, anything like that. Temperature, yeah. You're not using it, but it's on the thermometer, so that's a form of math. 98.6 is normal, right? So that's math." And "When I worked in a factory, we made fan belts ... We had to measure them if they're too long or too short. We had to use a cutting machine to adjust, if too long or too short. What I had to do if they were too long, I had to cut 'em or sew 'em together ... measured by two sticks to check if they were right. Measured in meters I think it was." And "During the windstorm our fence got blown down. We had to go back out, measure everything, and, you know, put it up. How far apart everything would be and then figure out how much fencing we needed."
Measurement is essential to our sense of ourselves and our orientation to the world. For example, as one teacher states, "I work with 80% welfare mothers, 20% low income ... They work with people in nursing homes ... Some don’t have that concept, measurement. They have to do measurement. How tall someone is. How much they weigh. 5'10" can be like 4'10" to them. Kind of things we take for granted about how we see our world. We try to bring them to something that’s real in their lives so that they will tie into it and try to generate some trust in that."

Because measurement is used so often and in so many contexts, many learners have great confidence in their measurement skills. For example, "We sell fry food and chicken and fish. The fish, we sell a lot of fish, fried fish. For example, the fish is $3.99 a pound. And the people say, 'I want $15.' I don’t have to go to machine and check how many pounds is $15. We think and we fry a lot of fish and we separate and exactly for the customer $15. I do that every day." And, "I am night manager in a restaurant, so I have to order every night. I have to do a balance for everything. Everything by the pounds, like sugar. See how many pounds I have and how many pounds I need to order."

For ESOL learners, teaching measurement is very important as a cross-cultural component of mathematics and second language learning, since many of these learners have used the metric measurement system much more than the U.S. system. For example, as one learner states, "In addition, it’s very difficult for us to use the American system. I think about mathematic, and American system about labor, pounds, miles, yards, because in European you have metric system. I heard United States try to change to this system, 2000. You change now?"

Learners and stakeholders recognize that measurement skills can be critically important. As one learner states, "I worked for Nabisco as a mixer. You had to know the correct scale and formulas. I kept messing up. I lost my job. It doesn’t look too good on the record. If you don’t know math, you can’t succeed." Or, "I just remember, in my job, I use in my country ... nurse. When the doctor tell me you have to give 25 milligrams, I have to. This is very important with medicine. You have insulin, you have to know." And, "carpentry work. Making sure the measurements are correct so that you don’t waste too much and so that you don’t have to do twice the work, by having to redo the work over." And as one employer states, "In the workplace, the common thing would be—we measure everything. If someone is measuring something and they are taking samples and then see that it is going out of the acceptable margin. I mean, they need to be able to stop everything and get someone to find out what is happening."

Time management is another critical measurement skill. As one employer states, "Time management, that is math. People have no sense. It is a work ethic, or break down of. We used to have a schedule ... Some people don’t get what being to work on time means ... being late and putting stress on all that must be completed by the time
the door opens ... forgetting how long it would require to do all the food prep." Or as one learner states, "In my work I must count the time I work. The time I begin work and the time I stop working. I write it or not. Good to check. That week if the boss count it exactly, I can check it." And as another learner says, "You need to figure out how much time to plan so you can get to places on time. You need to figure out when the bus comes, how long it takes to walk to the doctor's appointment, and everything." And from another, "Just time basically, time in a day."

Some adult learners identify geometry (along with algebra) with failure. "The hardest part for me is geometry." "Learning geometry was really hard."

Other learners recognize their excellent everyday skills in geometry, although they may or may not use the term "geometry" in relation to these skills. "Three or four years ago, I took up quilting and realized how much geometry you need when you go to modify patterns or create patterns. Estimating only goes so far when you're dealing with little, tiny pieces. When they're fairly big, you can estimate and you're okay. I did addition, subtraction, estimating, did a lot of work with angles. Who knows what else. I don't even remember my geometry well enough to remember the terms but some of it took going back to books and some of it was pretty straightforward." And, "I use math to figure how to shoot pool shots. I know where you need to hit the ball so it will go in the pocket."

Some adult learners don't see geometry as useful. For example, as one learner states, "Like geometry is so esoteric, with the angles and things. You think to yourself, what am I gonna use it for. You think, what's the point? ... This stuff they put in there just to mess you up."

However, geometry is and can be related to all aspects of life: home, school, work and community. Geometry and spatial sense can be used to describe the physical world. For, as another learner sees, "Geometry is everywhere. Not everything is square." And, "We have four horses. Once we had to figure how much hay we'd need for a year. Then we had to figure if the hay would fit in the barn. So one horse eats about a bale a week, so multiply by four and so on. Then we had to know how big the bale was. And how big the loft was." Or as another learner states, "I remember six months ago we had moved from a house in Annandale to Alexandria and the house we had moved in, it was no carpet on the floor. So we had to use our old carpet. It was good, not that bad. We had that carpet. The house we used to be before, it was bigger. This one was smaller. The carpet was bigger than we need ... We had to measure the room and the hallway exactly what it was. We had to cut the pieces of the carpet that we had to fit exactly the room. So we had to make a map of the paper and how we gonna cut it. How many feet. How many centimeters. Exactly how it's gonna be and it was good using the math. We did some mistake. We had some left over. The next time, maybe we do fine."
Implications for Teaching and Learning

Use exact and estimated measurements to describe and compare phenomena to increase the understanding of the structure, concepts and process of measurement. "Despite the fact that competency in measurement is vital, some adult basic education learners have difficulty selecting and determining appropriate units of measure as well as using the appropriate tools of measurement ... Teachers should use concrete activities (with non-standard and standard units) to help ABE learners develop an understanding of the many measurable attributes of physical objects (length, time, temperature, capacity, weight, mass, area, volume, and angle). This is the natural way of building a vocabulary for measurement, and for comprehension of what it means to measure." (Massachusetts ABE Math Standards, p. 53)

Address the impact of measurement skills on self-efficacy and self-reliance. As one learner points out, "Recently, I transformed my storage room into a walk-in closet. I needed to decide how large I wanted the clothing racks to be which depended on the size of the closet, the amount of space I needed left over for walking space, a bureau, and other items that are stored inside. Basically, math is everywhere, and to be independent and survive on a limited budget you need to be able to do things yourself and find the best values along the way."

Extend measurement skills to concept areas such as volume, proportion, and problem solving. As one learner points out, "I bought a couch last fall and miscalculated the footage on it. Then I had to rearrange my whole living room. It needed to go where the entertainment center was, but it was also big. It really got complicated, and I really was surprised at how challenging it was to get everything to fit." Or, after Oregon flooded, "We had a situation where we had to move some stuff out because of the flooding. We had to rent a truck. We needed to figure out how big a truck to rent. Was it really going to be more cost effective to rent one big truck or two little trucks? We had to figure out how may boxes we would need, and how many boxes would fit in a trailer."

Increase the awareness of acceptable tolerances (margins and upper and lower limits) and the consequences of being within and outside of these tolerances. To return to the workplace, where "we measure everything ... They are taking samples and then see that it is going out of the acceptable margin. I mean, they need to be able to stop everything and get someone to find out what is happening. Upper and lower limits, check that against a blueprint and see that the upper and lower limits have been put in properly, then compare that with how it was running earlier that day. Someone has got to understand ... someone's got to be putting in the data properly. It is computerized, of course, but it is only as good as the information that someone is putting in."

Start from the learner's strengths and make the instruction practical and useful for learners to overcome their fears regarding geometry. Provide opportunities
for learners to make connections between instruction and real-life situations common to their lives. As one workplace learner states, "I think like in these examples you have in here where we used real workplace kind of examples rather than some kind of theoretical examples that didn't apply. How many rolls of paper fit in the truck? What's the area of the truck, the volume of the truck. Real examples like that—that means something to your everyday job." Or as another learner says, "Learning volume here is easy because I can see it as something in front of me. It's easier for me to figure out if it's hands-on." Or as another learner states, "I like learning volume and shapes because in landscaping you can visualize in your head the shape to determine how much fill or sod. You need math to compute the job." Or, "the best learning was when I am at work using my tape measure."

Focus on hands-on problem-solving and give special attention to developing spatial sense in order for learners to develop an understanding of geometric principles. As one participant in the "Virtual" Study Group states, "Spatial reasoning which in my mind includes not only geometry, but measurement and the ability to visualize. It is often the visual and concrete models that can help people understand and learn what we want to teach about number and statistics. In addition, being able to realize that this kind of reasoning, this part of mathematics, often helps students who have talents in this direction realize and accept that they do have mathematical potential."
ALGEBRA: PATTERNS AND FUNCTIONS

My high school algebra class was really hard. I didn't know what I was doing and I felt like I was the only person without a clue.

I've used every math skill I've learned with the exception of algebra.

Algebra is the gatekeeper.

Overview

Should algebra be on the "honest list?" The Conference on Adult Mathematical Literacy voted on "informal algebra" as one of four basic topics to include in adult numeracy education. NCTM's Curriculum and Evaluation Standards, The Massachusetts ABE Math Standards and other reform movements include it as a critical skill. But say the word "algebra" to any group of adults (ANPN focus groups, for example) and the reaction is negative, with personal stories of frustration and sheer agony spilling out. Is the general perception that "there's really no use for it" a signal that we drop it from the list of instructional topics or is the answer simply to improve instructional practice? This area of mathematics presents a challenging dilemma, because what appears to be a case of the experts want it but the people say no, may be more a case that the two groups are talking about apples and oranges.

When adults reflect upon what it means to do algebra, they tend to recall formal methods of equation solving, age problems, and a lot of x's and y's. But mathematics educators at all levels have begun a dialogue with a very different emphasis, one that "moves away from a tight focus on manipulative facility to include a greater emphasis on conceptual understanding, on algebra as a means of representation, and on algebraic methods as a problem-solving tool." (NCTM, 1989, p. 150) They are not talking about the mechanical high school algebra but algebraic reasoning that allows us to think about and express patterns, relations and functions and which ultimately gives many more people access to technology (e.g., spreadsheets and relational data bases).

Key Findings

Many frustrations are connected to past experiences with algebra. "I remember my father standing over me at the dining room table attempting to drill into my head the algebra x, y, and x + y. I couldn't understand how anyone could understand it and why anyone would want to." (Stakeholder) So many adults cite algebra as a major stumbling block in their earlier mathematics education, the place where they got stuck. "Math is pretty easy (division); but algebra, forget it." "Algebra in ninth grade was hard for me. The teacher would do a problem and I was lost. I really felt out of place." "Algebra is hard." Whatever the reason, many learners report an incredible disconnect at the
point when algebra is traditionally introduced. "I never had any trouble with math in school until I got to algebra." "Math was pretty decent, and then when you got to algebra it was like they totally switched it all the way around."

There is a widely held notion that algebra is not practical, relevant or useful. "What is it used for? You don't use it unless you're teaching it or you're going into some kind of manufacturing type deal where you actually make diagrams, but otherwise it's no use. I use math everyday, fractions and so on and so forth, but I just don't use algebra or geometry."

Algebra is a bridge between arithmetic and more broadly generalized mathematical situations. Mathematics is the study of patterns. "Learning to recognize and analyze patterns and number relationships connects math to the world." (Massachusetts ABE Math Standards, p. 42) These generalizations can be expressed in the notation of formulas and graphs.

Many life and work experiences can be expressed in algebraic terms. While most adult learners do not see the relevancy of algebra, and many teachers see the academic relevancy, employers and other workers do see application to today's workplace. "Our union has a formula to calculate union dues. Dues are based on a weighted average, because not everyone in the union made journeyman at the same time. Some journeymen make $14 an hour, and some make $22 an hour. So you have to take so many $14 an hour, so many $16, so many $18, so many $20 and take a weighted average. And there's another equation: twice your weighted average plus your life insurance plus your union payments..." (learner) One person mentioned an unusual algebra application. "I read an article about how they determine how long someone will actually stay in prison or jail. There is a formula that they use that factors in things like good behavior and work release. With this formula, the sentence that someone would get from the court can be reduced a certain number of days, so the inmate can get out earlier than originally expected." (learner) The Massachusetts ABE Math Standards hold that "life experience has afforded adult basic education teachers with a broad base of real-world ties which can be readily linked to the concepts of equation, function, variable, and graph." (p. 46)

Algebraic thinking skills are crucial if adults are to compete in the global economy; therefore, all adult learners should have the opportunity to improve in that area. While the SCANS Report doesn't get very specific in math content areas, there is support within the document for going beyond the very basic skills and including thinking skills. And beyond that, the "five competencies" that build upon the foundation skills imply the need for some algebraic competence, especially in the areas of "information", "systems" and "technology." SCANS stresses the need for organizing, interpreting and communicating information and employing computers as a tool for those tasks as well as the ability to "discover a rule or principle underlying the relationship
between two or more objects and apply it in solving a problem." Identifying and expressing pattern, relation and function are the algebraic skills imbedded within these competencies. When the teachers who wrote The Massachusetts ABE Math Standards say "the opportunity to study algebra should be available to any adult basic education learner who may have missed it due to past educational experiences," (p.46) they are calling for a chance for adult learners to compete in the global economy.

Algebra impacts the competency of workers, parents and citizens. Workers who are involved with technology cited several examples of algebra use. "I did marketing analysis using Lotus 123 to forecast exponential marketing sales vs. quotas to determine sales regions. In the manufacturing area I was 20 years old and three top managers couldn't figure out an algebraic formula and one of them very jokingly said, 'Here, see if you can solve this,' as they all laughed at the thought. However, in one minute, I solved the problem to determine their daily production which they couldn't do. " (learner) " We're teaching students at the Great Lakes (Naval Base) all different facets of shipboard life..., and one of the big things we teach up there is electronics... Ohm's law, it is simple basic algebra."

We heard from many parents enrolled in adult basic education classes who don't like the fact they can't help their children. " They're (her children) always asking me why I don't know about algebra. So I told them about what happened in the past. (My daughter) can see how automation is coming in with computers and all - and she knows if you don't know it, you'll fall through the cracks, be on the street." " Back when I was growing up, we didn't have to (take) things like algebra and geometry, and now you have to know these things. Like my son comes home with papers that I can't even do." "My kid's doing algebra in 6th grade now. I'm trying to help him out."

When asked to talk about math skills needed to be a successful community member, one learner replied, "While basic math skills, e.g. adding and subtracting, are obviously important, it is also useful to have a working knowledge of algebraic language. I am surprised by the opportunities I've had to use 'algebra mind,' which I was unaware of before I acquired it. For instance, I know now that God didn't create complex mathematical problems; the 'Math Wizard' did. Because I have an understanding of how these formulas happen, I am able to apply that knowledge to creating formulas that work for me. 'Algebra mind' has also made a contribution to my daily thought process. I find myself thinking more critically and analytically, which is a nice side effect of all the problem solving ... In my opinion, any person who thinks more systematically and analytically is bound to be a better citizen ... crime rate, parenting, population, welfare and many other social concerns. Better thinkers think ahead. 'Algebra mind' should be taught as part of social reform."
Implications for Teaching and Learning

Improve algebra instruction by providing effective staff development. Teachers need to relearn algebra through the lens of patterns, relationships and functions, how it's applied now to the real world, and need to know a diversity of approaches. The learners' curriculum should reflect these same elements.

Introduce all learners to algebraic concepts by making links to the learner's experiences. "I learn better if I start off with something I already know. When I worked in marketing...If you go back to the basic formula and link it to an easier way. Because the more I learn the easier it gets. Link it to something you already know and you'll get it, you'll remember it."

Pay attention to instructional pace, vary teaching strategies and strengthen the development of concepts to improve algebra instruction. Learners suggested that the source of the trouble might have to do with the pace of the instruction. "To me, an improvement might be to slow down...and maybe dwell a little more on it." "There are so many concepts to grasp at one time, you need more time." One stakeholder suggested that a better understanding of the large concepts might have helped. "I remember finding it (9th grade algebra) the first time I was frustrated with math. And I would get the right answers but not the way the instructor got them. I have since learned that I am highly intuitive. I probably skipped some steps along the way but it was frustrating and difficult for me to go back and fill in to tell him how I got there. I have since (worked with) some algebra materials which were sort of an 'aha, that's what I was supposed to be learning.' I think it would be more fun and exciting to study those math concepts now because I would have a much clearer idea of why I was learning and what I was doing and there'd be things like missed calculations that computers and calculators could help with so I could really focus more on the concepts."

Connecting to the Four Purposes

Algebra supports the key purposes for literacy. How can algebra be a door-opener rather than the gatekeeper to higher education and well-paying jobs? Skills and knowledge in the area of algebra help adults access information that is presented in written and oral mathematical symbols. Conversely, the ability to represent information and relationships with algebraic symbols, graphs, or everyday language strengthens voice. The ability to reason algebraically (to think logically), to recognize patterns and generalizations provides a scaffold for problem solving and decision-making.

Effectively taught, algebra can be a source of empowerment for adults as parents, workers, and citizens. It should not be the "sieve" and the hurdle that keeps people out.
COMPETENCE AND SELF-CONFIDENCE

You have to go back many decades ago when I was in grade school. That's where I first think about math -- same thing, the times table. You were under the gun to be able to verbalize. I can recall hitting the wall at 6 times something or other and that was the end of it. I couldn't go farther. Fear was a motivation. In those days, if you didn't produce, you flunked. So I learned methods of getting to the same answers but not the standard subject methods. I never could figure out how, say a, b, or c, had values to it in algebra, and that was sheer agony. I got into geometry. I was in a private school, in a very small class. I knew where I was in the class, maybe that was (my) self-image, but the problem was some of the fear of math, so the first time I flunked it. Then I changed schools and never told anybody I'd taken geometry before and I got an 'A' the second time through it 'cause I had to take it to get the math credit. And I like geometry but that's about where we stop... I was supposed to take physics and did not and I avoided math. I've learned my own methods from dealing with where I needed to do math.

Overview

In focus group after focus group, adult learners and stakeholders openly shared their positive and negative experiences with math. They shared their best experiences with math, and from whom they learned math. The also shared their worst math experiences. When given a choice -- a good experience or a bad experience -- the results were striking. Many more learners, and a good number of stakeholders, described their lack of confidence and competence in math. From the discussions, it became clear that many adults fear math and especially lack confidence in their ability to handle the math taught in classroom situations.

Key Findings

The loss of self-confidence in math, the lack of understanding of particular math concepts, and fear of math inhibits power. Adult learners and stakeholders alike often remembered experiences that discouraged them from enjoying math and appreciating its potential. In focus group after focus group, adult learners reflected on particular experiences when they had difficulty learning math: "In second grade I had trouble with multiplication. The teacher just forced it down my throat and expected me to memorize it and I just couldn't do it." "Math was okay until seventh grade when we started fractions. I had no idea what was going on and the teacher would not explain it." "In seventh grade I started to have trouble with geometry. I still have trouble with the GED geometry. I don't know why we have to learn it. It's so confusing."
Many adults do not feel confident, competent, or comfortable in math. "I don't like math. We don't get along. I just don't like it. Adding and subtracting was okay, but when you get to dividing, fractions, and algebra, it just gets hard." "All math is frustrating." "I've always been really dumb in math."

Many adult learners are frustrated because they do not feel competent in math. Comments like "Doing homework with the kids is most frustrating for me because my kids do math better than me," or "Working with my daughter at home is really frustrating. I won't let her use a calculator because I don't want her to get dumb like me," or "I want my kids to be able to do math like I couldn't" reveal that sometimes this frustration shows up when dealing with their children's math homework.

Adult learners and stakeholders alike, in some cases, fear math. As stated by one stakeholder, "I was taught to fear math." Or as stated by learners, "I like math but I'm scared because I can't divide." "Math makes me terrified and tense."

For some learners, frustration with math spread to frustration in other areas of school as well. For example, one learner related, "I am not good in math. When I was in school and we started on decimals and fractions, I could not catch on and my teacher wouldn't help so I got behind in class and could not keep up with everyone else so I just gave up completely on all of school so that no one knew that I couldn't do it and (I) quit school. I don't even like it anymore."

Is this lack of confidence in math because people are limited or lack the ability to learn? Certainly not. The causes are more likely found in poor learning environments and lack of recognition of different learning styles and needs. As one learner stated, "I didn't understand math because the teachers wasn't explaining it right from the base. They was getting to, they were starting the middle part of it and I didn't understand the first part of it and I never could understand math." Or as another learner noted, "Mine was high school, too. It was close to what he was saying with the problem with a teacher ... It would be at the point where maybe I wouldn't grasp something and you try to ask questions, and it seemed that, if you were in the minority that had trouble, it was always see me after class. It seemed you were being pushed to the side a little bit. Maybe I didn't get enough where you drill with it and it gets repetitive, but it was like the majority got it, so that was good enough, so we went on to the next thing. So that was when I just fell behind."

Good learning environments — within the family, at work, or in school — produce different attitudes toward math and can help to overcome fear and lack of belief in one's ability. Confidence builds competence in math and competence builds confidence. The learner quoted above who "could never understand math" when talking about his current ABE experience stated, "Now I understand it perfectly. I used to hate math; now I love it." Or as another learner related, "Here, when I ask them ... I feel
that builds up your confidence level and self-esteem ... they always try to help. It makes me work harder than ever." Or as another learner states, "I hated math but the football coach made it interesting to me. So I had to learn to deal with it. The coach made learning math fun." Or within the family: "It (math) was my best subject. My grandfather helped me a great deal when I needed help. He was very helpful to me because he was a carpenter." And "my mother was the one who would help me the most with math. I would work at it by myself until I would get frustrated ... so I would ask her to help me and she would sit down and explain things to me."

Sometimes confidence in math comes after gaining self-esteem as an adult. One stakeholder explained, "Now that I am older, I feel much more confident in the math I need to do. I wouldn't voluntarily go back and take a higher math course, (but) math doesn't frighten me. I have more confidence in myself ... This was nothing I was taught. It is something I picked up." Math skills are also acquired on the job. For example, when learners were asked to describe a good math learning situation, they responded, "The people that helped me was my boss at work;" "The best learning was when I am at work using my tape measure;" and "I worked in a Chevrolet parts department and learned more math on my job than in school."

Those learners that feel comfortable with math have confidence in their ability and respect for the domain of math. "I bought a house last year. The price of the house sounds pretty inexpensive, but when you add up the interest on it, the points they charge you, the closing fees, the maintenance. It's like on a 30-year loan, you end up paying three times as much as the house is worth. You gotta compute simple interest, compounded interest, all that sort of stuff. First I took what I made a month. I took an average, then I deducted all my expenses, then I had a budget saying what I could afford to pay a month. Simple math. Only you divide that if you have a roommate or whatever. Just basic planning and basic math skills, averages. When they first tell you, 'Just put down 5% or 10%, then pay this much a month,' you take it like that and you don't know what it really costs you. You gotta figure everything else. That's what math does, it makes you organize, makes you think in a certain manner." Confidence in math increases power, voice, and the ability to act. For example, "I went into the store. The lady had an item that was supposed to be discounted, I think like 50 or 60% off ... And she brought it up and it didn't sound right to me, and I was in a hurry that day and I really didn't have time to figure it out on my own. So after I got home, I figured it out. I went back to my math book and looked at the amount that was supposed to be discounted and it was wrong. And so I kept my sales receipt and I took it back and I got six dollars back. She was wrong."

The more adults learn, the more confident they become, and the more enjoyable the experience of learning becomes. "The more you learn, the more fun it is." Stakeholders explained how knowing how to do math improves confidence. "In 1946, in high school, I was taking geometry and the teacher made it so clear that I actually under-
stood what I was doing and thought that I was really good in math!" "It's funny, most of the stuff I thought of (about learning math) didn't have to do with school ... I learned a lot of my math as a kid from my dad and it was one of the few things that he did with me so it was important for that reason. I have clear memories of the two of us looking at a word problem together and my dad always drawing pictures of whatever was going on in the problem. And my growing up with a sense that I could figure anything like that out. All I had to do was draw a picture of it. I have a memory when I was in the sixth grade, when I was getting kind of bored with math, my dad saying, 'Oh, well, do you want to learn algebra?' So I have clear memories of him basically teaching me how to write sentences in math and leaving holes in the middle of them and plugging letters in. So I had this great confidence in my ability to do it, partly because I had a dad who assumed I would be good at it and who kind of instilled me with that."

Implications for Teaching and Learning

Teachers need to become comfortable presenting math concepts using a variety of strategies and approaches. This suggests that teachers need staff development where they can share with each other successful teaching strategies. Teachers need to become comfortable using manipulatives, calculators, computers, whatever it takes for learners to grasp math concepts. A stakeholder suggested, "I have five children in their twenties, but they missed out on math somehow. I don't know where math education has gone to but I think we need to go back and educate the teachers." Another stakeholder shared her own personal experience with becoming comfortable with other approaches: "I thought of last year. I was teaching reform calculus for the very first time. We had completely switched over to reform calculus, Harvard Reform Calculus which involves a lot of manipulatives, a lot of graphing, calculator work, a lot of computer work, emphasis entirely on understanding and not on manipulation. I came up through a very traditional background which most of us all did -- the rote, go home, be able to do 50 problems and all that stuff. All of a sudden, I was faced with teaching these students all these concepts without showing them the manipulations but actually get them to understand the concepts not just how to do it. I sat back with other instructors. We met on a very regular basis to share our woes. And we said, 'Don't know why we ever -- now it makes sense.' We just sort of did it by manipulation before. We now understood. So I learned probably as much calculus as my calculus students did. Now that's a terrible confession. And it was amazing the complex concepts that my students could understand before I had even shown them the algebraic manipulations to do something. We didn't show them the manipulations until afterwards and it was just phenomenal and so I learned a lot of math, they learned a lot of math. I learned a lot about how to teach math."

In recent years, more research has been done in the area of math learning. This research has revealed that individuals learn math differently. Some are comfortable with learning step by step procedures while other learners tend to jump to the big picture
and work forward and backward to solve problems. Teachers need to let go of the need to make all learners solve problems the same way that they were taught in school. An adult learner shared how this step by step method does not work for him: "It (math) was hard because they wanted you to write everything down, every step you took. I did a lot of it in my head. I couldn't write how I'd done it 'cause I'd done it in my head. I had the right answer but I couldn't write down this is the step, this is the step, because I'd done it in my head. They'd try to show me the steps but it didn't always look like how I had done it."

**Success needs to be built into the adult education classroom.** Adult learners need to have success early on and often when they begin a math class. This success enables them to develop confidence in their ability to do math, which in turn paves the way for further positive math learning experiences. All individuals benefit from positive feedback, but it is particularly important that adults who have experienced failure in math class previously now find success in the adult education classroom. As one adult learner put it, "It (math class) can be just as interesting as a social studies class, and the positive feedback is the best thing. When my teacher told me when I was doing something, that I really was a good thinker, I felt so good! That sounds really dorky, but it's the truth." When asked what recommendations should be made in math instruction, stakeholders offered these comments: "We need to build confidence in our students;" "People lose confidence in math because they don't realize that they are already doing lots of math and that can be built upon;" and "The other thing is, that I really noticed, more than any other subject area, when students feel competent in math, their self-esteem really grows and their confidence in themselves as learners really grows."

A stakeholder voiced her concern, not about the adult education classroom, but the K-12 system. Because she felt that her daughter might not get supported to be successful in math, she had to take on this responsibility as a parent. "The other thinking that was important for me as a kid and that I've tried to do as a parent — not so much math skills — the belief that my kids will be good at this and can be good at this. That it is logical, simple, always do-able. That's probably the other piece out of this as a parent. Especially for my daughter because I assume a little less that school will give her that message — but the belief that she's good at it (math)." Another stakeholder reflected on her past experience in math: "I have sadness that no one ever said to me, 'You're really good in math.' I was good in math."

**Math content skills need to be presented in the context of real-life situations.** When learners can immediately apply what they have learned, the learning crystallizes and the learners gain confidence and competence in their math ability. When asked about his experience learning math, one adult learner responded, "I picked up some stuff from me helping my father. I used to know, like all the money. We owned a restaurant back home and every day he gives me the money and at the end of the month, I used to add it up, let him know what we got. That helped me a lot." A suggestion from
a stakeholder was to change the perception that math is difficult: "We need to start over and completely redesign the way math is taught. There should be more application. The current application attempts to teach application with too much theory and in too convoluted a way. The perception is that math is too hard and that perception must be changed."

Connecting to real-life situations and understanding the why behind math processes improves math ability. A stakeholder, even though she enjoyed math as a child, shared this revelation, "But I always felt good about math. I always enjoyed math. It was in college then, in teacher preparation work, that I picked up a lot of why I was doing it and the background and it would click and then it made more sense at that point than previously when I was just repeating a process."

Adults use math in their daily lives but often do not connect their real world math to the math in the classroom. When asked whether they use math, adults who are not confident in math will often say that they don't use math yet they earn wages, spend money, buy gas for their cars, and so on. Connecting math to their real-life situations helps adults understand that they do use math. A stakeholder suggested, "... Building on the familiarity that they (adults) do have. I think that one thing, we estimate, we talk about adults' wealth of experience, but that experience has given adults math intuition -- the way that they've dealt with it -- so we can find strategies to go with their own intuitive way that they've walked through things. It is very natural for them. I think you'll find this with some of the women students, that they've developed some strategies that they can build off, solve their problems." Other stakeholders added, "People lose confidence in math because they don't realize that they are already doing lots of math and that can be built upon." "Most people don't perceive themselves as being math literate. We get through the classes, we get a 'B' in algebra, maybe we get an 'A' in trig, but when we get out, we perceive people who are math whizzes are engineers, or physicists, people who are in math fields. Most people in this country do not perceive themselves as being math literate and so we shy away from it."

There needs to be a level of trust in the adult education classroom. The adult education teacher needs to build an environment that is comfortable for adults and one in which adults can be open. Adults need to feel comfortable sharing their frustrations and lack of math skills. One adult learner shared how he felt a need to "expose" his lack of times table knowledge to his teacher, "Well, math is hard for me, but I can learn it. The hardest part for me is the geometry and the division. But, if I knew my times tables right off the top of my head, I could get all of it. I don't know all my times tables right off the top of my head. I could work the problem out but my time tables slow me down. When I go into the classroom I'm going to have to explain to the teacher on the outside of the door that I'm not good in math and she'll have to explain it to me over and over again. I will get it eventually, but it will take time. Once I've got it I feel good about myself when I get it because math is the hardest thing for me." A stakeholder explained
what she values in an instructor: "With my staff, what I think is successful -- what is just as important as the academic background a person brings with them to the classroom, the knowledge that they have -- is the ability to interact with students on a personal basis. Being able to sit down and talk to them as human beings, let alone just as students that sit in front of you and I have to teach them this material. Most of the students that I have had or I have talked to whether in the alternative high school or adult have had negative experiences in educational programs. As a result, that is why they quit. Coming in, they say, 'Well, people care about me here'. That just raises their self-esteem ... gets them on target again ..."

Connecting to the Four Purposes

For adults to be literate enough to accomplish their goals, they need to understand and use math. When adults do not have a handle on math, they have difficulty coping -- whether it be in their role as parent, worker, or community member.

The following adult learner lost his job because he was not able to read scales to access information: "I worked for Nabisco. As a mixer you had to know the correct scale and formulas. I kept messing up. I lost my job. It doesn't look too good on the record. If you don't know math you can't succeed."

This adult learner expressed his feelings about how it is difficult to have a voice because he lacks confidence in his math ability: "I guess I'm not too comfortable because I lack a lot of knowledge (in math)."

These adult learners were not successful in making decisions for work. "Dairy Queen wouldn't hire me because I couldn't make change in my head. I couldn't give the answers in an oral quiz to making change questions." "In the bank when I had to 10-key, do some things with checks... couldn't put it in the machine. If I messed up checks, I couldn't work. I quit the job." "One time I was at work and this guy came up to my register, and I rang all this stuff up. And when my register opened, he gave me like $20 or something. And he's like 'Oh, wait a minute, I have the change.' And I'm like looking at him and I'm like, Oh my God, I have to figure the whole thing out and it took me about five minutes. The register doesn't do it for you. Dealing with money and stuff is important. Sometimes when they give me extra change and stuff, I just ignore it and then say, 'Oh, I'm sorry.'"

Math skills, knowledge and abilities are gatekeepers. To bridge to the future: to get a job or a better job, to go on to college or to create a brighter future for their children, adults need to understand math. "My daughter asks me about that (percentages) so I'm teaching her a little about that. They're always asking why I don't know more about the algebra and geometry and stuff. So I told 'em about what happened in the past. She can see how automation is coming with the computers and all -- and she knows if
you don't know it, you'll fall through the cracks, be on the street." And this adult learner now understands that math is critical to moving ahead. When asked what was a frustrating math experience, he replied, "Math in general. In school we had to know it all at once. We had to go on or else. Some like me never went on."
CONCLUSION AND RECOMMENDATIONS

The National Institute for Literacy issued a wake-up call to the adult education community with the publication of *Equipped for the Future*. The voices of the 1500 adult learners motivated those who work in the field of adult education to respond, to critically evaluate, and ultimately rework the curricula, instructional and assessment practices, program structures and supports currently in place. Similarly, the *Framework for Adult Numeracy Standards* documents the voices of adults who tell us about the significance of mathematical skills and knowledge in their lives. These voices create an expanded definition of numeracy, one that includes much more than computation or passing standardized tests. This emerging definition encourages all of us to give voice to our mathematical understandings, to take joy in accessing information and making meaning via a solid sense of number, data, geometry and spatial reasoning, and algebra. It insists on the importance of making informed decisions and solving problems through the use of quantitative and spatial reasoning, and most importantly, it defines a numeracy that is situated in modern, relevant situations and addresses skills necessary to cope with present and future societal demands.

The adult education community needs to commit itself to this broadened definition of numeracy. Let's step back a little further. The adult literacy/basic education field needs to include numeracy in its agenda period. Not as an afterthought, but in a basic and systemic way. Numeracy must become an integrated component of all ABE, GED, ESOL, family literacy and workplace learning environments. Policy makers, administrators and curriculum developers on the national, state and local program levels need to include mathematical literacy in their mission of providing a second chance to adult learners. Classroom teachers must step forward as leaders in reform and take on the challenge of creating mathematically empowering learning environments. Failing to take action means that we're willing to turn a deaf ear to what parents, workers and community members have told us. Because we cannot consider that an option, we now turn our attention to what it might take to make lasting reform happen.

**Recommendations for System Reform**

The *Framework for Adult Numeracy Standards* is a consensus statement about what the content of adult education classes should include. Each of the seven numeracy themes include key findings and implications for learning and teaching that are intended to serve as a map for adult education practitioners and policy makers as they take the important next steps toward reforming instructional programs for adults. The ANPN Working Group members and several study and focus group participants have begun to speculate about how we're going to make those next steps happen. What will it take to create learning environments that support quality numeracy instruction? We have polled the members of the ANPN Planning Project for System Reform and have also
drawn upon the focused discussions which took place at the Conference on Mathematical Literacy. We are in agreement that several necessary conditions and system components must be in place for our vision to become a reality.

**The Necessary Conditions**

- Reform has a chance only if it is supported at all levels: national, state, and local. It has to be both bottom-up and top down with ongoing opportunities for people at the different levels to dialogue.

- Learners must be meaningfully involved in the development of each system component.

- Teachers must be meaningfully involved in the development of each system component.

- Realistically adequate resources must support all system components.

- Numeracy must be included in literacy reform.

**The System Components**

The following is a discussion of each system component needed to support the changes called for in the framework and suggestions for initial strategies for beginning the improvement in these areas.

**Communication/Dissemination**

A group write a document . . . a tree falls in the forest. All stakeholders need to hear our "sounds," and be invited to make noise with us. Strategic dissemination is key all along the way. And so is two-way communication that both explains and invites feedback. We knew this as we began to talk about reform two years ago, so we established a communication structure through the Adult Numeracy Practitioners Network (ANPN). ANPN publishes a quarterly newsletter (*The Math Practitioner*) and has two very active Internet communication mechanisms: the ANPN Homepage and the NUMERACY listserv. We need to disseminate the framework and all subsequent products and processes through the network and through other existing adult education channels.

For the system to be reformed teachers have to know what the work environment requires and what is needed by the community in order to better prepare adult learners. There must be ongoing dialogue with industry if, in fact, the curriculum is to change to
meet the needs and expectations of the workplace. There must also be communication with community stakeholders -- for their input into math reform and for them to become comfortable with the new approaches to math.

Adult education is able to react to system reform much more quickly than the K-12 system, but it should not have to work alone. Communication must occur across schools, K - 12 as well as community and technical colleges. Other institutions that work with adult learners, specifically community and technical colleges, need to be at the table during the discussion of system reform, and they must be making every effort to move forward along with adult basic education.

While effective communication needs to occur across schools, communities, and industry, it must begin within the adult education system. According to the Conference on Adult Mathematical Literacy (p.7), "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 and 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."

1996 - 1997

- Expand circulation of ANPN newsletter (from 1,000 to 10,000). Disseminate to local learning programs via state ABE offices and literacy resource centers and to national stakeholders. Focus discussion in the newsletter around the numeracy themes. Publish excerpts of the document in the September, 1996 issue to begin the dialogue around numeracy themes.

- Continue Internet dialogue. Make the Framework for Adult Numeracy Standards available on the ANPN Homepage.

- Rework the July, 1996 draft framework for dissemination to ANPN members, state directors, resource centers and the mathematics education community.

- Present draft framework at at least five state or regional ABE conferences.

**Numeracy Content Learning Standards**

The Framework for Adult Numeracy Standards should be used to develop a more specific set of learning outcomes that in turn guide the development of curricula, instructional materials and assessment. Questions that need to be considered are: What is
the "grain size" or specificity level of a learning standard? What generative and specific skills support each standard? How do we address levels of proficiency? Do we use one set of standards with benchmarks or do we create three or four? How do we refine and validate the standards?

1996 - 1997

- Form an ANPN Working Group to co-develop Adult Numeracy Standards. Expand the Working Group to members from ten states who are supported by and report progress to their state ABE offices. Develop working relationships (possibly subcontracts) with NIFL-funded projects so that the work remains in sync with and informs the EFF Project.

- Participate in EFF Working Groups and meetings.

- Begin simultaneous teacher research projects that begin to explore and implement components of the numeracy standards in adult education classrooms across the country. Use this research as a way to begin classroom reform. The experience of NCTM, the MA ABE Math Team and several state curriculum framework development groups is that engagement and experimentation must begin before the final document is complete. Ownership by a critical mass of practitioners will create a real base of support.

Curriculum

The numeracy learning standards will guide adult learning programs as they update their curricula to respond to current and future demands of workplaces and communities. Local programs and states will utilize the standards to evaluate and, in some cases, develop their own curricula. State resource centers or collaboratives might pool resources to develop model curricula. Major funding should be sought to support the development of this component.

1997 - 1998

- Seek a partnership with the National Science Foundation, the National Council of Teachers of Mathematics, the Departments of Education and Labor, private industry and foundations to fund the development of a comprehensive adult numeracy curriculum based upon the learning and performance standards.

- Call together the developers of the major National Science Foundation-funded K-12 mathematics curriculum projects (Interactive Mathematics, Connected Geometry,
and Investigations in Number, Data and Space, for example) to consider the possibilities of adapting these projects to adult learning environments.

Assessment

Once clear numeracy learning standards are developed as statements of what adults should know and be able to do, we need to think about developing new performance and assessment tools. What kinds of evidence will show that people have met the standards? How will we test what we value? How do we align assessment with content standards and the curricula based on those standards? Too often, the testing instrument, whether it be the TABE or the GED, drives the curriculum. When a learner's only goal is to pass a test, it is difficult to teach math concepts needed for real life. Unfortunately, it often doesn't matter what adult educators consider the most important concepts or topics to teach. Students are very likely not to think of them as important unless they are reflected in the tests and assessment. No matter what assessment is designed, unless it is incorporated into individual instructor's assessments, GED exams, job placement tests, and the like, it will get lost in the need of both students and instructors to address what does appear on those assessment tools.

As more and more industries are beginning to consider national skill standards that are portable, adult educators need to follow closely to see what implications these standards might have for adult learners. How might industry skill standards affect how we should be assessing adult learners? Evaluation and assessment needs to communicate to learners a range of what they may need to learn and to certify that learners have mastered competencies so that employers and colleges will honor learners' educational accomplishment. We should assess and certify adult learner's workplace readiness with respect to math. While we're looking at industry standards, we need also to look to business and industry to find out just what skills are needed to succeed in the work environment.

Assessment tools need to be designed to evaluate the ability to "process". How well do individuals and groups problem solve? How are their reasoning skills? Is it possible to design concrete benchmarks for the process skills -- problem-solving/reasoning, communication, connections/relevance? How do we know when an adult is reasoning mathematically?

1996 - 1997

- Establish a numeracy assessment work group to collect promising assessment practices from across the field and outside of ABE (K - 12, industry, and from other countries including Australia, the Netherlands and Great Britain where interesting work in the area of numeracy assessment is happening).
1997 - 1998

- Establish a work group to develop assessment models that provide good evidence of mastery of the skills and knowledge called for in the learning standards.

Staff Development

Ongoing staff development is critical for math reform. One stakeholder stated the need for staff development this way: "We have the same teachers we had yesterday, so without staff development, we will have the same teaching we had yesterday. We need to help teachers teach in a way they were not taught."

Too often in adult basic education programs, teachers are expected to be proficient in all areas — math, reading, writing, social studies, science — yet most adult educators are trained in only one of these domains, and rarely in the math domain. Therefore, many adult education teachers are uncomfortable with math. Teachers need professional development in order to improve their own math skills as well as change their attitude and perspective toward math. We need to help teachers understand math concepts, not just be able to follow the steps. If we continue to teach the way that we were taught, math will continue to be an elitist subject, only accessible to a very limited number of individuals. Until teachers see the value of math to real life situations, they will be unable to help their learners connect to math.

Along these same lines, teachers have to become knowledgeable and comfortable with the workplace. Teachers often teach the same concepts in the same way that they were taught. If teachers have no awareness of what math skills are needed for work, they cannot possibly begin to prepare their learners for work environments. There needs to be communication between business and adult education with opportunities for experiencing hands-on what workers need for today and the future.

Staff development requires more than simply having adult education teachers attend training sessions. Teachers need opportunities to develop ongoing peer relationships where they are supported as they explore new strategies in their classrooms. Any kind of reform or change is scary. Teachers should not be expected to try to reform their practice without support.

1996 - 1997

- Support existing and establish new statewide teacher math teams to plan and conduct staff development to learn new math content and pedagogy. Draw upon the expertise of NCTM and ANPN members and include employers in content discussions. Use the ANPN newsletter, homepage and electronic discussion groups to share learnings between states. Bring representatives of teams together in April 1997, at the ANPN/NCTM annual meeting.
Instructional Practices

Changes in instructional practice go hand in hand with staff development. Adult education teachers need to learn new methods of presenting math topics in the classroom. For example, many teachers have not been trained to use manipulatives to present math concepts. Typically, they were taught to follow the algorithms which is what they, in turn, teach their students. Yet many adult learners related that they learned best during hands-on activities. A part of staff development should be building teachers' comfort level with using hands-on materials.

Rather than the perception that the teacher is the one with all the knowledge, the new perception for math reform is teacher as "guide on the side" or facilitator. Teachers need to incorporate into the adult education classroom many opportunities for learners to discover math for themselves. Supporting learners to work together and share their experiences will be necessary for system reform in math.

Conference participants suggested that "diversity in the classroom" was a reality which should be kept in mind as we talk about system reform. Diversity includes differences in linguistic and cultural backgrounds as well as diversity of learner goals and learning styles. For teachers to be prepared for this diversity in every adult education class, there must be effective staff development and support systems in place.

1996 - 1998

- Create and provide opportunities to encourage teachers and programs to share promising practices. These opportunities may include teacher inquiry projects, math study circles, and peer coaching projects.

Instructional Materials

The math materials developed for adult learners need to be seriously revised. Most of the materials presently available "often reflect some of the worst traditions of K-12 mathematics education" (Proceedings of the Conference on Adult Mathematical Literacy, p. 6). There seems to be very little awareness of the MA ABE Math Standards and little evidence of any effort to provide learners with practice in process skills, such as reasoning and problem-solving. Very few materials offer open-ended or cooperative problem-solving activities for adult learners.

1996 - 1998

- Meet with and hold focus groups of publishers of curriculum and assessment materials. Strategize about ways to develop materials based upon the new standards.
Resources/Funding

Adequate funding and resources are needed for change. Obviously, staff development requires funding earmarked for teachers to be able to seriously work on improving their math teaching abilities. For staff development to truly have a positive impact in the classroom, per student funding needs to be increased. Added funding is also necessary to ensure that adult learners have opportunities to use tools such as computers and calculators.

Appropriate salaries and support for more full-time teaching positions, would recognize and support teachers to invest more in their profession and to actively seek to change the system.

At the Conference on Adult Mathematical Literacy, funding was called out as a critical factor in system reform. The lack of adequate funding negatively impacts adult education programs in four ways: 1. Limiting achievement of goals, by causing programs to be understaffed and under-equipped, and by creating time and financial restraints; 2. Limiting preparedness of teachers (and tutors), by restricting availability of and access to pre-service, in-service, and professionalization opportunities; 3. Inhibiting development of instructional materials and not allowing for adequate experimentation with new methods and resources; and 4. 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. (Proceedings of the Conference on Adult Mathematical Literacy, p. 7)

1996 - ongoing

• Ongoing work with the National Institute for Literacy and EFF to strategize about obtaining funding to support system reform.

Research

There is little research on how adults do mathematics or how they acquire new mathematical skills. There is also very little on the effectiveness and impact of adult numeracy instruction. This information is essential to guide us to improve instructional programs. If we are to enter upon major reform, we must be supported by a research base.
1996 and ongoing

- ANPN will seek to partner with the new National Center for Adult Learning and Literacy and other centers of research on adult learning and mathematics learning.

Program Standards, Outcomes and Evaluation

Participants at the Conference on Adult Mathematical Literacy recognized that accountability demands affect math instruction and reform. There is concern that current methods for ensuring accountability -- the use of data such as standardized test results -- do not truly reflect or measure learner's accomplishments. As long as funders expect this kind of accountability, teachers will be inhibited in their ability to truly address the needs of their adult learners.

Some major industries are now focusing on developing industry-specific skill standards. If these standards are implemented and used as a basis for hiring, these standards will have to be a part of the discussion on math reform. Will there be some basic math content and skill that all industries feel is critical to employee success?

System reform must build in an accountability system so that we’re not in the same place twenty years from now. We need to develop standards that everyone can understand and accept. Then we need to be held accountable for preparing our adult learners so that they can meet these standards.

1997 - 1998

- Continue dialogue with all members of the Equipped for the Future Project and the US Department of Education to connect the newly developed standards to the Department of Education's Indicators of Program Quality.
References


APPENDICES

Group Membership
Timeline
Focus Group Guidelines
Coding: Initial and Final
The 3 Roles: Data
Topic Prioritization Results
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<tr>
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<th>Role</th>
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<tr>
<td>Susan Cowles</td>
<td>Convener, Oregon Study Group</td>
<td>Linn-Benton Community College, Albany, OR</td>
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<tr>
<td>Judith Rake</td>
<td>Director of Literacy</td>
<td>Secretary of State's Literacy Office, Springfield, IL</td>
</tr>
<tr>
<td>Donna Curry</td>
<td>Product Coordinator</td>
<td>Workforce Development Consultant, Westport Island, ME</td>
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<tr>
<td>Nancy Roper</td>
<td>Mathematics Department Chair</td>
<td>Portland Community College, Portland, OR</td>
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<td>Judith Diamond</td>
<td>Convener, Illinois Study Group</td>
<td>Adult Learning Resource Center, Des Plaines, IL</td>
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<tr>
<td>Mary Jane Schmitt</td>
<td>Project Co-director</td>
<td>Massachusetts Department of Education, Malden, MA</td>
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<tr>
<td>Martha Gilchrist</td>
<td>Convener, Virginia Study Group</td>
<td>Roanoke City Schools, Roanoke, VA</td>
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<td>Judy Storer</td>
<td>Convener, New England Study Group</td>
<td>Portland Adult Education Center, Portland, ME</td>
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<tr>
<td>Glenda Harrell</td>
<td>Human Resources Consultant</td>
<td>Corning Incorporated, Danville, VA</td>
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<tr>
<td>John Yirak</td>
<td>Policy Analyst</td>
<td>MassJOBS Council, Boston, MA</td>
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<td>Esther Leonelli</td>
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<td>Sally Waldron</td>
<td>Project Co-director</td>
<td>SABES, World Education, Boston, MA</td>
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<td>Nancy Markus</td>
<td>Convener, Ohio Study Group</td>
<td>Ohio Literacy Resource Center, Kent State University, Kent, OH</td>
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<tr>
<td>Denise Shultheis</td>
<td>ABLE Supervisor</td>
<td>Ohio Department of Education, Worthington, OH</td>
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<tr>
<td>Jan Phillips</td>
<td>Convener, Illinois Study Group</td>
<td>Wm Rainey Harper College, Palatine, IL</td>
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<tr>
<td>Pamela Meader</td>
<td>Convener, New England Study Group</td>
<td>Portland Adult Education Center, Portland, ME</td>
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</table>
The Teacher Study Groups

**Illinois**
Kathy Conrad, Independent Consultant/Instructor
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Beth Ann Leaf, Illinois Corrections
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Donnasu Moody, South Suburban College
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Patsy Byers, ABLE Network, Washington
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Christine Ferguson, Eastern Oregon Correctional Institution
Diane Ferris, Portland Community College
Tom Gregson, Oregon State Penitentiary
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Mary Mayfield, Lane Community College
Ann Steiner, Chemeketa Community College

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Ido Gal, University of Israel, Haifa
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Susan Gear, Workplace Ed, CA
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Victoria Hoffman, Texas Center for Adult Literacy and Learning, TX
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Myrna Manly, El Camino Community College, CA
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Michelle Reagan, Workplace Ed, ME
Joe Sackett, ANPN Board/Regional Representative, NM
Eileen Simons, ANPN Board/Regional Representative, NY
Rose Steiner, ANPN Board/Treasurer, MT
Pam Wall, ANPN Board/Regional Representative, LA
Fancher Wolfe, Metropolitan State University, MN
Cynthia Zengler, Ohio State, OH
Participants in the Stakeholder Focus Groups

Ohio
Karen Scheid, Executive Director, Ohio Literacy Network
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Jeff Gove, Administrator, JOBS Program
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Harry Featherstone, Chairman of the Board, Will-Burt Co.
Karla Hibbert-Jones, Executive Director, Project Read
Nancy Padak, Professor of Education, Kent State University
Chuck Casey, Account Executive, Ohio Bureau Employment Service
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Bernie Fallaw, Employee Training, MacLean Fogg Company
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Caren Van Slyke, Publisher, Learning Unlimited
Tess Reinhard, Manager of Operations, Motorola University
Dennis Terdy, Staff Development Director, Adult Learning Resource Center
ANPN System Reform Project
Timeline

Oct.
First Working Group Meeting

Nov.
Study Groups Meet
Examine Documents
Brainstorm Focus Group Questions

Dec.
Study Groups Meet
Conduct Focus Groups
2-3 Learner Groups/State
1 Other Stakeholder Group/State
Virtual Study Group on WWWWeb

Jan.
Working Group On-line Discussion
Develop Focus Group Questions

Feb.
Study Groups Meet
Document and Submit Focus Groups Results
Code Data

Mar.
Working Group On-line Discussion of Focus Group Results

Apr.
NCTM Meeting

May
Study Groups Meet
Data Analysis

June
Framework Completed and Submitted to NIFL along with Results and Vision for System Reform

July
Draft Framework for Adult Numeracy Standards Developed by Co-directors and Product Coordinator

Aug.
Second Working Group Meeting
Data Analysis
Vision for Systematic Reform

Sept.
GUIDELINES FOR RUNNING THE ANPN FOCUS GROUPS

The basic idea of a Focus Group Interview is simple. A group is brought together to discuss certain topics for two hours. The moderator raises various issues on matters of interest to our research according to a guide. Analysis of the gathered information attempts to discern patterns, themes or trends that develop among participants as well as across groups.

Ground rules that will be used for all ANPN learner and stakeholder focus groups:

- The focus group session should last about two hours.
- Size of groups are best if between 7-10 people.
- Groups should be homogenous. Do not mix learners and non-learner stakeholders.
- Two people will run the session. One to moderate and one to take notes. These are very separate tasks. The notetaker does not participate.
- Notes should be VERBATIM. Conversations may be taped. We strongly suggest the notetaker tape-record the session as a back-up to the note taking. It is not necessary to record off-the-topic conversations.
- Comfortable location is ideal. Studies show that location of focus group conversations affect the outcomes. Meet in a circle.
- All groups will use the same general overview, set of questions and collect similar demographic data.

Also keep in mind:
- Don't run 7 individual interviews. A good moderator gets people talking to each other. On the other hand, this is not a consensus. Ask open ended questions to get the range of opinion values.
- Moderator should be non-biased and comfortable with the group.
- Questions are best if memorized by the moderator.
- Questions should be neutral and non-leading. Non-value language should be used.
- Everyone should have a chance to talk. Talkative or disruptive people should sit next to the moderator. Shy people should be directly across.

(Mary Jane is sending a copy of two short articles on focus groups to the home addresses of Study Group Conveners.)
What should the product from each Study Group Convener look like when it is submitted to Donna and the rest of the Study Group Members?

All data that is documented should be captured VERBATIM. (Discussions that are off-the-topic do not need to be included.)

The information needs to be typed double-spaced.

There should be a very wide left-hand margin (for marking later); leave about 1/3 of the page for marking.

A hard copy and a disk copy (either Word Perfect or Word for Windows - a safe bet is to save the document in RTF format, if possible) should be submitted.

Information needs to be in Donna's hands/computer by FEBRUARY 15th.

Each Study Group Member should also receive a copy by February 15th.

Study Group Conveners will need to schedule another Study Group meeting by the end of February to analyze their Focus Group data. Before that meeting, each Study Group Member should have read all the responses from the other Focus Groups. We will provide you with more guidance (by the middle of January, hopefully) to help you as you look at the data. By the end of the first week of March (March 8th, to be exact), the analysis conducted by each Study Group should be submitted to Donna.

March 20th - 22nd Mary Jane, Sally, and Donna (?) will meet again in Washington, D. C. At that time, we hope to be able to compare our data collection with others also engaged in the same type of project.

As the project progresses, we will be able to give you more guidance. For example, the analysis we receive from you in March will guide us in what happens in the April Study Group meeting.

And, as we discussed in length in Boston, the process is as important as the final product, so ENJOY!!!
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<th>Your ethnic background?</th>
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Thank you.
Focus Group Participants (Compiled List)

Who ran the Focus Group?

Where was the Focus Group held?

When was the Focus Group held?

What time was the Focus Group held?

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### Learning and Teaching

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### Empowerment

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<td>S3</td>
<td>Instructional Practice</td>
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<td>S9</td>
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<td>Teacher Preparation</td>
<td>S10</td>
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<td>Relevance/Connections</td>
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<td>Problem</td>
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<td>Whole Numbers</td>
<td>C3, C4, C5, C6, C7, C9, C10, C13, T7, T8</td>
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<td>Competence and Self-confidence</td>
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THE THREE ROLES: PARENT/FAMILY MEMBER, WORKER, COMMUNITY MEMBER

Parent/Family Member

I use math with snacks with my children. How many crackers they want. How many they have.
Separating food for meals
Mixing formula for babies
Dividing candy or toys
Giving them medicine
How many people you have to serve, and how much food you need
To teach your children how to count, homework, etc.
I can help assist and teach my children basic math problems and resolutions.
I also have used math to help my daughter with her high tech class. How to measure for a pin-hole camera, the length from the hole to the mirror, and the angle of the light when it hits the mirror and then the film helping their kids ("I don’t want my kid to have the same trouble I had in math. I want them to do well and be able to get a scholarship and go to a good college.") ("I want my kids to be able to do math like I couldn’t.")
My kids ask me all the time - like a division question or something. My kid's doing algebra in 6th grade now. I'm trying to help him out - in school now it's a must to know algebra and geometry when you graduate - so they're starting it clear back in 6th grade.

Telling time. My daughter, she's like "I don't know how to do that." She doesn't recognize time and she's 11! Plus she asks me to help her with division.
How tall a child is
Measuring carpet
Just the overall running of a household ... checkbooks... there's bills, rent, always a million things in everyday life that you're going to use mathematics on... if you don't know math, how are you going to balance your checkbook... a credit card...
Advancement in life
Time - free time, overtime, work time, playtime
Keep track of time
For is important because my brother is in high school. We learn math in my county, my sister and me, we explain to him a lot of things he don't understand, we explain him in Spanish but it's the same math, same rules.
We use math in my family because we live on a farm and when the season comes and we have to think about how many crops we take for us, and much for our government and how many we take it (in Viet Nam).
To pay bills or to give allowances
If you have bills, you pay 20% interest, is it better to pay off the bills and not save anything - or is it better to save the money - you think what's the prime rate or the interest rate - you need math everyday to survive.
Balancing checkbooks - figuring out how much bills are as to how much you bring home as to how much you have left over.

Yeah, how much fun money you get after you estimate the bills.
Budget plans for your family.
Count family members
Cooking
Measurements (cooking)
How many sandbags you have to fill to stop a river
How fast is the river rising...
The seawall is 31 feet high...
When will the river crest?
How much pressure on the plywood would crash the barrier?
Buying cars and houses
Building models
Carpentry
Cost of building a house
Improvement of home value
House expenses, you want to change your house or decorate
Measuring
Haircuts
Laundry settings
Timers
Grocery shopping
Budgeting
Card games/scoring, etc.
Computer games (estimation skills - whether to stop or not)
Clothing store
Shopping to compare prices
Coupons
Accounting for doing the banking
Do your taxes
How do you or how could you add up all your stuff/receipts
Property size/value
Gardening
Raising cows, pigs, hoes, etc.
Asking the child to spend her own money for some groceries or practical things, so she learns how much things cost.
Also specials. Like taking 30% off - what we're learning in here. My daughter asks me about that so I'm teaching her a little about that. They're always asking why I don't know more about the algebra and geometry and stuff. So I told them about what happened in the past. She can see how automation is coming with the computers and all - and she knows if you don't know it, you'll fall through the cracks, be on the street.
When my husband is short on money, he'll claim more deductions on his W4 for a few weeks and then change it back. He has to be really careful - last year he got a little carried away, and we ended up having to pay at the end of the year. This year he's watching it more closely. You don't really see it if it comes out of each check, but it's hard to come up with a whole bunch of money for taxes if you don't have it.
During the windstorm our fence got blown down. We had to go back out, measure everything and put it up.
How far apart everything would be and then figure out how much fencing we needed. And then my family has sheep - we have to figure out a price. So we figure how much to feed them, how much average they eat. We had to use a lot of estimation, multiplying, adding and stuff.
If you're working on a job they take taxes out. When you go on unemployment, they don't you have to do that. If you don't do that correctly, you have to pay at the end of the year. So I had to figure about 26% and put that money in the bank so I could earn a little interest.
We have 4 horses. Once we had to figure how much hay we'd need for a year. Then we had to figure if the hay would fit in the barn. So 1 horse eats about a bale a week, so multiply by 4 and so on. Then we had to know how big the bale was. And how big the loft was.
When I was married, my wife was smart, so she took care of the bills. When I got divorced I took my boys. I was off work for a year and a half, plus I had bad debt for credit cards. Made $6 an hour with two kids. Had to feed them and pay some on my bills. So basically I'd figure out how much food we'd need for the week and how much gas it took to get to work and pay for that first. Then I'd pay some on the bills. When the kids needed clothes that came first with the food and gas. I didn't have a checking savings account - I can't spell or do math - I'm really crappy with numbers, I always get them turned around, so I have almost always just paid cash for everything.
When you are driving your car. You use math constantly, everyday of your life, everything has to do with math. When you drive your car, you have to figure out your mileage, how long it is going to take you to get form one place to another, when you are driving the kids and playing taxi service. If you have children, of course, it is in your everyday living.
From your family, if you have a large family, time scheduling, if you've got kids going to school, 13 minutes in the bathroom
When you have to pay for your kids to go to college
Dieter, some people work on their weight
Bus scheduling
If you get a certain percentage of interest from the bank, which is 3% or 4%, you could put it in a long-term mutual fund or CD, you get this much.
Insurance
Car expenses, brakes, transmission, rims, stereos, speakers
Key chains, car phone, bus fare for those that don't have a car

Worker

If you work with people and deal with money you need to know how to make change.
Adding hours for paycheck - we are required to keep track of our own and write our paycheck
Working in bank - need to know how to count money
When you're making out people's checks, I do that every week. You got to figure out their deductions. When I pay my workers, I make their checks out.
My wife does payroll she uses percentages all the time
Keeping personal time card for hours worked on job. As a production worker it helps you keep count of pieces you have done.
I can use math to help with a/r, a/p, and payroll, daily cash reconciliation.
Most jobs require math skills. As cashier, counting money, adding, subtracting. Math can be used for payroll, time cards, receiving tips.
Cash register ("You need to be able to make change when you work the cash register")
Hours worked ("You need to figure how many hours you've worked so you don't cheat yourself and work too much")
How much of a raise we get
How much time to get to work?
When I worked, I had to punch a clock.
In my work I must count the time I work. The time I begin work and the time I stop working. I write it or not, good to check. That week if the boss count it exactly, I can check it.
Figuring out a recipe. I worked in a restaurant for a while. And you knew the recipe was for 50 people - and 150 showed up. And you had to figure out how much to increase.
.... I do recipes, you gotta know math for that . . . sometimes you got to take a big recipe maybe one time, half time or maybe two times the recipe, not very hard math, just basic math
You use math just figuring mileage. How much it is to and from some place. How much gas it's going to take to get to the job and from the job. So you don't end up halfway through the week not being able to get to work.
How much to put aside for transportation back and forth to work - otherwise there's walking of hitchhiking
Making PC boards
Airplane speedometers
Cutting (butcher)
Measurement at work ... metric
In my job I have to order fuel - I have to stick in a tank to see how many gallons in tank - how many to order - underground gas tank gauges
My dad is a carpenter - he uses math
Loan processor- I have to call banks, employers, appraisers, insurance to get credit records. I use adding, percents, find loan to value, appraise to 90% of value, explain fees. Some people don't have enough to pay the fees.
Customer service - deduct money wasted from a bill add, subtract, divide. When the power goes off - then the computer goes off. I would have to get a piece of paper.
Where I work is an expensive place. Sometimes I have to void out something. People get angry when they don't want something and you have to take time to figure it out
On customers returns, you have to watch when you give money back. Some people cheat on change but I tell them I counted it back. They don't understand cost per pound. If it's 19 cents per pound and they have to
pay 20 cents they don't understand and argue. Lots of sales during Christmas are red tag with 25% off. 15% already given off. They return the items and don't want the sale price. It was a good deal but she thought she was losing money.

... even other people like a garbage man, you still gotta figure how much work you have to do the rest of the day, they may be just simple numbers, but you're doing math every day.

I use math most of the time at work because I work at the stock selector. I am putting parts away every day. You know I am putting like one load of 460 in each can and there is nine or six–ten trays so I have to put how many in the whole load and put them away.....

Counting parts
better ideas products
Work orders - calculate the amounts of skid I'd put a barrel of sigs on pallet
Bricklaying
I am night manager in a restaurant, so I have to order every night. I have to do a balance for everything. Everything - by the pounds, like sugar, see how many pounds I have and how many pounds I need to order. We sell fry food and chicken and fish. The fish, we sell a lot of fish, fried fish, and the people... for example, the fish is $3.99 a pound. And the people say "I want $15". I don't have to go to machine and check how many pounds is $15. We think and we fry a lot of fish and we separate and exactly for the customer $15. I do that every day.

When the customer want to buy something ... sometimes the machine is broken and because the people run and we cannot stop that, we must think about the customer.

I knew that I was a musician and math was not the main thing in my life, but I knew that music and math are connect because we have to count every time. Math is very serious and music is very serious, too.

Being able to account for incoming and outgoing money.

Math will be useful and you will need to know different math skills to solve difficult problems.
Calculating salary and hours at work. Taxes on w-2 forms. take home pay, gross pay
Read a tape measure
Math in computers
Construction
Know your lengths
Measuring our portions
Selling AVON ("You need to figure the tax and know how much to order.")
Figuring tax
Waitressing ("figuring out what you made so you could pay your taxes")
Bar tending ("You really need to keep track of shots and also figuring the bills")
Machinist ("It has to come out exactly. He uses micrometers and calipers to make sure everything is just right.")

Nurses using measurement and fractions to give the right amount of medicine ("It would be really dangerous if you couldn't measure stuff right. You could kill somebody.")

Doctors for surgery to make the incision is the right length

At my part time job we use math for prescriptions, so an and so forth, so much per weight, milliliters, shots and something like that (what do you do?) Technician, veterinary hospital
Bookkeeper and graphic artist

Architect
Roofers
Teacher
Meter reader

A graphic artist needs to make the drawings smaller than real life
A meter reader needs to be able to read the meter
Construction
Baker - has to measure and stuff
Case worker - has to use a lot of numbers
Mechanic
Making back scratchers - you have to know how much the wood costs and how long it takes you to make one (cottage industry)
Like when you pour concrete, if you have to pay $500 for stuff, you need to charge $2,000 to make $500 profit
Insurance billing
Being a doctor
Bookkeeper
Motel business, I do the books for the guy who owns the Bunny Motel; he grossed $71,000 but he had to pay
for a roof and carpets and stuff.
I used math for building
I worked for Nabisco - as a mixer you had to know the correct scale and formulas. I kept messing up. I lost
my job. It doesn't look too good on the record. If you don't know math you can't succeed.
Cashier, making change. Dairy Queen wouldn't hire me because I couldn't make change in my head. I
couldn't give the answers in an oral quiz to making change questions.
In the bank when I had to 10-key, do some things with checks. I couldn't put it in the machine. If I messed
up checks I couldn't work. I quit the job.
When I first started printing 11 years ago. In the bindery, you have to know how many books you can get in
a box. Had to use calculators, but I didn't know how. Someone helped me. On the press, have to know how
many sheets, size to print. There are 3 ways to check the number of pages. The console has 2 counters that
show on press. The last couple of years (a new computer) weighs the ink and the paper and tracks how much
you print or throw away so you can print as many pages as didn't print in the first run. I have to use a
calculator there too. I have to start with the computer to keep track. I have to punch the number in on my time
sheet too. I've put 4000 prints instead of 40,000. Some guys catch it and tell me. It could cost me my job
if I'm not careful.
Every Friday a lot of people use math to see how much their check is make sure it is right
Basically at work every day you know just looking at parts I use a blueprint. That gives you a tolerance, a
couple thousandths there, couple thousandths there, sometimes 5, -2, and if you've got a part that's right on
the borderline of tolerance you want to decide if you want to just keep on running it or fix it or basically see
what kind of problem it is going to cause.
The SPC graphs I use, not very often

**Community Member**

If you're involved in a community project you have to lay out races by the mile or meter ... I've been involved
in figuring sidewalks for the elderly ... figure materials
House builders - have to have math - construction
Town board meeting for a school ... if you want to keep up with the cost they're spending ... so you can have
a positive value toward the expenditure -- if you want to figure how much it's costing you want to be able to
take notes to figure how much it's costing tax payers
City council has to pass a budget expenditure every year
You use it when you go to Town Meeting with different groups to raise funds. I've gone there to help 5th
graders raise funds to go on their Great Adventure. They sell coffee, hot dogs, that type of thing right during
Town Meeting. They buy a cup of coffee off a kit, a hot dog, a lot of different things like that. The kids each
brought in so much of everything. They had to figure out: so many people in town, and how many hot dogs
does they were going to need for that and how much bread. Then, they had to decide who was going to work what
shift.... We started out with a certain amount of money. The two kids -- when they finished a shift -- had to
check and then report to the next shift exactly how much they had.
Fundraising for schools and churches
You can also have awareness groups, community groups, people that are trying to get something done for
the community, a beautification committee, trying to get something planted in front of somebody's business ...
you have to raise money, you have to portion it out to figure out how much you would use for this, what's
for labor, what's for materials.
The county option tax
I help Jessie (an elderly woman) with her homeshopping and the bills and Stuff on the first of the month and
write the checks.
You might have a business that doesn't have fair business practices, maybe that's charging unfair rates or twice as much as the guy down the street.
You have to count how many people register to vote
Yesterday my friend call me and she is now going for the election we need 300 votes. What she going to work, this is a new party and we just told this new party we take from the old party. We just make this new party, if this succeed or not, we know that amount of people that going to this party, like this membership votes - have to have a certain number of people
"You use math to see if someone won an election."
Voting ("You have to know whether someone is winning or losing")
You pay your parking tickets. When you pay for your dog running loose in the street. Oh! $50: Dog at large
When you pay tickets, like driving tickets, speeding tickets, tickets when you go around the railroad tracks when you're not supposed to
City stickers, city fees
Taxes
Technology
Teaching
Work habits
Charity donations
We are looking for how many people smoke, and how young, like that.
Helps you divide the time you work in one area. example: 2 hours picking up trash in neighborhood, 3 hours serving meals at soup kitchen, allows person to space the time he or she has to space
Helping others in any way may require computation and basic math skills
Any type of assistance as a community worker would require math skills, fund raising projects, welfare, helping people pay bills, insurance.
Daily living requires math skills
Learning about spreadsheets, record keeping you keep up with latest events in the community
Putting groups together in neighborhood, planning fund-raising to feed the needy in neighborhood, giving Donations to charity
Finding someone's house
"You need to use math to determine your property line. Before you put up a fence you need to know that. You need to find zones."
"The census bureau uses math to count people. If you don't get counted they won't give you what you should get."
"Police officers use math to decide about speeding tickets. They have to know if you’re speeding and how much the ticket should be."
Charity contributions
Raising taxes
Comparison shopping
Buying (fast) food with a little money
Sentencing/ball
Politics
Our being aware of what's going on
If you go around collecting door to door, money for like cancer, what did they want me to do. You have to count your money up
Sometimes in the neighborhood, you have a party, you have to figure out how much money to collect at each house...if you have an activity or entertainment, you have to figure how much it cost and how much to charge each house.
Driving a cab - if someone gives you a 20 you have to give change
Playing baseball in the street and breaking a window you have to replace it. I had a car accident and hit a tree. They charged me for the tree.
Garbage - In Elmwood Park you have two things for garbage and have to pay extra for extra garbage - that's recycling.
There are fines if you don't recycle.
At work we ask for a dollar for charity, muscular dystrophy, and put a green shamrock on the wall. Some
regular customers refuse to give.
I do my own taxes
Sell raffle tickets
Bake sales
Kids on an outing
Deciding how much money to give
Arts and crafts
Neighborhood watch - scheduling
Trading baby-sitting
Cleaning the street - how many bags

Student

"You need to know this stuff to get your GED, like geometry and fractions"
By working with my tutor, I learned to write checks and stuff
You need math for other subjects too. You need to count how many words you've got for a writing assignment or how many pages
RESULTS
LEARNER AND STAKEHOLDER PRIORITIZATION
OF
MATH TOPICS

Working in groups of three, please look at the following math topics. Pick the four most important and order them from most important to least important. You can add any other topics that you think are important that are missing. You can also take out any topics that you don't think are important. You should agree on the top four in your group. Be ready to explain why you picked these four topics and why you ordered them the way you did. The twelve topics were as follows: Problem Solving, Communication, Reasoning, Estimation, Decimals, Fractions, Algebra, Measurement, Whole Number Computation, Patterns and Relationships, Statistics and Probability, and Geometry and Spatial Sense.
## Learner Focus Group Results: Key Knowledge and Skill Areas

<table>
<thead>
<tr>
<th>Area</th>
<th>Ohio</th>
<th>Oregon</th>
<th>New England</th>
<th>Virginia</th>
<th>Illinois</th>
<th>Total</th>
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<tbody>
<tr>
<td>Communication</td>
<td>Third 13 pts</td>
<td>First 28 pts</td>
<td>First 19 pts</td>
<td>First 26 pts</td>
<td>First 66 pts</td>
<td>18 152 pts</td>
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<td>Second 14 pts</td>
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<td>Third 30 pts</td>
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<td>Second 15 pts</td>
<td>Third 16 pts</td>
<td>Third/Fourth 13 pts</td>
<td>Third 15 pts</td>
<td>Second 39 pts</td>
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<tr>
<td>Fractions and Decimals</td>
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<td>Third/Fourth 13 pts</td>
<td>Fourth 10 pts</td>
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<td>2.5 23 pts</td>
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<tr>
<td>Whole Numbers</td>
<td>Fourth 11 pts</td>
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<td>Second 20 pts</td>
<td>Fourth 27 pts</td>
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<td>5 58 pts</td>
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<tr>
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<td>Second 23 pts</td>
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<td>4 33 pts</td>
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</table>

**Ranking by State's Priority:**
1. Communication  
2. Problem Solving  
3/4. Estimation and Whole Numbers

**Ranking by Totals (top 4 only):**
1. Communication  
2. Problem Solving  
3. Whole Numbers  
4. Estimation
**Learner Focus Group Results: Key Knowledge and Skill Areas**

**Combined Totals for Each Area**

<table>
<thead>
<tr>
<th>Area</th>
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<th>New England</th>
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**Ranking by Totals:**

1. Communication
2. Problem Solving
3. Whole Numbers
4. Estimation
5. Reasoning
6. Fractions and Decimals
LEARNER PRIORITY TOPICS

What do learners mean by "communication"?

The teacher has got to get through to you. (OR-St2)
To be able to communicate ideas. (OR-St2)
If you can't communicate, you can't learn. Without communication you can't do anything. (OR-St2)
You must be able to communicate to understand the problem; you have to be able to read it, or speak it--explain the process. (OR-St1)
You have to communicate with one another to solve problems. (OR-St1)
If you can't communicate to us what the problem is, all the rest of these pieces of paper are moot... If you can communicate to us what the problem is, then right away the brain starts to function. "Oh, let's see, that's going to be about so and so." (OR-St3)
And then we had to communicate what the problem was. (OR-St3)
It makes more sense when you think about the way you process things. That's why we put communication, reasoning and problem solving all together...You have to communicate to understand the problem. (OR-St3)
Communication and problem solving seem more relevant because, obviously, you have to communicate to understand the problem. (OR-St3)
Basically you need communication to come up with new and better ideas. (IL-ST1)
You need communication to get along with one another. (IL-St1)
Communication is the way we start. (IL-St1)
We need communication so that we can understand and be understood. (IL-St1)
I vote communication because first you really got to learn. (IL-St2) In order to understand what to do next. (IL-St2)
Communication is like what we are doing in class. But we're learning a lot of stuff in the class that we're going to have to use. Once we learned how to use, then we...according to the situation, we can say we don't need to use this. We can use this. (IL-St2)
Communication, everybody does it. You have to speak clearly and listen. Everybody likes to listen. (IL-St2)
Communication. We picked communication first because you have to communicate with the teacher and, like I said before, I tell the teacher what I don't know so she can work with me helping me understand what I don't know. (IL-St2)
And number four, go back to number one-communication is very important. You know, say, for instance, you are working on a mortgage company, and then you're communicating with other salespersons which is selling the house and they they told you well, it is this much rate and you look in the papers and it is a different percentage rate on that and so you communicated with the real estate person. Sometimes they want you to pay all the points for the house and you say why don't we pay half and half, half to the seller and half to the buyer. And that is communication. (IL-St3)
Because if you don't communicate with people wherever you go, whatever you buy, you don't do it. You have to communicate with everybody so the second one "organizing and understanding data." (IL-St3)
First is communication...let's say you're going into math ignorant, you gotta be able to
communicate or to get you a grasp on the other stuff...if you don't know how to talk and ask for help, you'll never get nowhere...after you communicate your problem, you gotta use reasoning to reach your goal. (IL-St4)
Communication because it's the first thing you gotta understand...if you don't understand the problem, if you don't understand the words, the wording, then you can't really solve anything. (IL-St4)
You can't just expect everybody goes into a situation knowing something about it...they're gonna have to communicate...they have to get some help from others. (IL-St4)
You start off like this. How to read and understand, you need to listen. (IL-St5)
If you don't know what you're doing, you can't solve it. You can know a formula or how to add, subtract, multiply or divide, but don't understand and then you can't solve it. (IL-St5)
We based ours on everyday life. Communication is the key. (IL-St6)
You have to communicate in order to listen and understand with somebody else. (IL-St6)
I looked at communications...is like the heading for all the others. (IL-St6)

What do learners mean by "problem solving"?

You need to solve your problems. (OR-St2)
You have to know how to do problem solving before you solve a problem. (OR-St2)
You need to find the important information to solve everyday problems. (OR-St1)
If you do the other three (communication, reasoning, algebra), you should be able to problem-solve. (OR-St1)
And then with our problem solving techniques that we use, either textbook, brain power, calculator, or whatever, then we can go through all the different equations, all the different geometry, algebra, whatever else you have, and come right down to the decimal point or what you need. (OR-St3)
It makes more sense when you think about the way you process things. That's why we put communication, reasoning, and problem solving all together. (OR-St3)
Communication and problem solving seemed more relevant because, obviously, you have to communicate to understand the problem. (OR-St3)
We did problem solving, reasoning, algebra, and geometry. They kind of go together with problem solving. We had to put those together to get to the problem. (OR-St3)
Problem solving. You need that everywhere. (IL-St2)
Problem solving. Using different strategies and that is calculators, measuring, computers. (IL-St2)
Problem solving is about the problems we have and resolve these using tools, calculators, computers whichever. (IL-St3)
Problem solving for me would be something on the floor that we make you know by using one of my--like a caliper to measure it--and if it is over by so much you know you fix it. I send my part somewhere and they have a problem with it saying your gauges. You know this part won't screw into this part. You know it's got to be fixed. So that would be problem solving. (IL-St3)
Number one problem solving. The way I look at it, say for instance, you got a problem, not a problem, but at home. You got a wife. You know you ready to buy a house, and then at the
same time you know, you think about a long trip. You want to spend so much money. And then this problem that you're going to solve between you and your wife. Either we pay for the house or we take a trip. And if we take the trip, don't tell me later you want to buy the house and this and that. That's the way I look at it, math. (IL-St3)
You have to understand the problem in order to solve it. (IL-St3)
Problem solving because you want to solve the problem. You want to buy, whatever you're going to do, you want to solve the problem, right? (IL-St3)
Number three-problem solving. Maybe you won't have to figure it out. Maybe you could use a calculator or computer, use some other source to try to help you achieve your goal as far as solving your problem. You could use another kind of tool or an unconventional method. (IL-St4)
Problem solving. That's when (you) sit down and you think about how you gonna do this. Are you gonna add it up. If it's too big to add up by your hands or pen, you gotta get out a computer or calculator or whatever. (IL-St4)
Basically in our group we have problems with comprehension. We need to know how to do whole numbers. If you don't know how to solve it--it won't get done. You need to know what you're doing. (IL-St5)
Problem solving helps you go back and check it with calculator or computer. (IL-St5)
If you don't know what you're doing, you can't solve it. You can know a formula or how to add, subtract, multiply or divide, but don't understand and then you can't solve it. (IL-St5)
Problem solving. Use calculators to solve problems. (IL-St6)

What do learners mean by "whole numbers"?

Whole numbers, calculations. Because patterns needed to build buildings, relationships. (IL-St6)
Whole number pattern relationships. (IL-St6)
Basically in our group we have problems with comprehension. We need to know how to do whole numbers. If you don't know how to solve it--it won't get done. You need to know what you're doing. At grocery stores, I can estimate--to do it in my head. (IL-St5)
Although whole numbers are nice, they aren't the numbers in real life. (IL-St5)
Our first was whole numbers...If you don't know whole numbers, that is the basis that everything else is built upon...I mean how can you do any other type of thing if you can't do the simple whole number computation...Right there you're starting with one foot in the hole...How are you gonna be able to communicate a mathematical problem to someone else if you don't know the basic numbering system. (IL-St4)
Then comes whole number computation...That's pretty much the basics of math...using basic ideas to come to your conclusions. (IL-St4)
I agree, communication is an important thing...But if you don't understand basic whole numbers and decimals, how can you communicate that? (IL-St4)
I disagree...I think whole number computation is most important...It's a basic, fundamental thing. For example, there is a tree...if the root is weak, the tree's life will not be long. So we have to know the whole number computation first because it's basic...the root of the tree. (IL-St4)
First one we thought that the whole number computation is like basic, everything basic that you
use as far as math. If you don't have the basics, you don't know how to use anything else. (IL-St3)
Whole numbers...Ain't that one more like adding and subtracting and all that. You do that every day. (IL-St3)
More or less with your basic bank accounts, things like that has to deal with everyday living once again, but eventually that will end up into your computer situations anyway. (IL-St2)
And then after that, we felt whole number computation would be the most important just in terms of being one of the most basic tools for finding the answer. (OR-St3)
Whole number computation: because it's the first thing you should learn. (OR-St2)
Whole number computation: must be basically literate. Before you can communicate you have to know how to add and subtract before you do fractions, for example. (OR-St2)

What do learners mean by "estimation"?

Having a variety of fractions, decimals, percents. Like how much is 10% off of something. (IL-St6)
At grocery stores, I can estimate it—to do it in my head. (IL-St5)
Then estimating helps you take shortcuts. (IL-St5)
I'll tell you why I didn't pick estimating, because I'm not going to do it on the test. I overestimate when I go to the store but I'm not going to shop on the test. Estimating can help you pace yourself for time on the test. (IL-St5)
And estimation we put down because it's another thing I believe people use every day. You go into a store, you got 20 bucks, you're going down the shelf, you see this is almost $2...You use estimation all the time...how much time it takes to get to school. (IL-St4)
You get up late, you estimate how long it takes to get ready, if you need to speed or not speed when driving. (IL-St4)
Four was estimation. Estimating in real life situations which you do I think. (IL-St3)
I kept thinking of holding a weight in each hand...is one heavier than the other? Well, let's see. Just from feel,... (Question: That's estimating, though, isn't it?) Reasoning.
Reasoning...estimating...reasoning, logic...conclusion. I'm reasoning one's heavier than the other. And then be able to communicate that. Then do your estimation using whole numbers. (OR-St3)
Because you estimate with everything every day. You go grocery shopping. If you got five dollars you can only get so many things. You round it off, you know estimate, on how much everything is and so when you go up there you know how much you've spent. (IL-St3)
Number three is estimation. The way I look at it too is that you know how much money everything you live is about money. You know estimation how much we want to spend in a house or something--a house for $300,000, you know we can't afford it so we got to estimate. (IL-St3)
And the last one estimation. You want to have estimation on whatever you plan to do...You go to the store you want to make sure you have enough money. You estimate it in your head. (IL-St3)
Estimation: you need it for work, at home. (IL-St2)
And then we thought if we could estimate an answer, that would be a good thing. (OR-St3)
Estimation: seems right. (OR-St2)
## Stakeholder Priority Topics

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**Values:**

- 1st = 4 pts
- 2nd = 3 pts
- 3rd = 2 pts
- 4th = 1 pt

**Rank:**

1. Problem Solving
2. Communication
3. Reasoning
4. Estimation
5. Whole Numbers
Stakeholder Priority Topics

PROBLEM SOLVING

Problem solving we’re using as a skill (ORSH)

The problem solving and reasoning may all go into, may be ahead of the measurement to determine, for instance, on the job jacket, what is it going to take for me to have that exact measurement or have this geometric design or whatever? (ORSH)

Problem solving: that we agreed on pretty quickly too--some sense about how to go about going after an answer. I am repeating myself, but it seems just so obvious, but the ability to solve problems and use strategies. (ILSH)

You might then actually add it up and then go to a calculator. (ILSH)

I would see problem solving as the reverse of reasoning. Reasoning, the information is given to you and you are drawing conclusions. Problem solving is just the opposite where you want an outcome or you need an outcome--you have to make some decisions and now you have to put the data together and solve the problem. (ILSH)

Inherently related to how you function in life. (NESH)

Math applies to life. (NESH)

Need to define a problem; computation alone won’t help. (NESH)

Reasoning

This, the problem solving and reasoning may all go into, may be ahead of the measurement to determine, for instance, on the job jacket, what is it going to take for me to have that exact measurement or have this geometric design or whatever. (ORSH)

But then reasoning, the ability to reason, draw conclusions, make judgments on data, we felt was more important even though we were limiting the spectrum of math skills. (ILSH)

... and then reason, making conclusions based on that estimation. (ILSH)

Reasoning, we thought in daily situations you probably see math statistics and math numbers; you’re seeing different information that you need to reason and draw conclusions based on this. Is this a good sale, not a good sale--and so forth depends on the whole reasoning process. Looking at graphs and charts, looking at your paycheck and whatever, just being presented with information and attempting to draw conclusions. (ILSH)
Reasoning, the information is given to you and you are drawing conclusions. Problem solving is just the opposite where you want an outcome or you need an outcome—you have to make some decisions and now you have to put the data together and solve the problem. (ILSH)

Reasoning—a subset of problem solving. (NESH)

**Communication**

These three clusters are interrelated and connected with communication. (OHSH)

To me this is the bridge—communication. If you can’t articulate how you got to where you’re at or what it means. (ORSH)

My thinking is using communication as a bridge and being able to openly talk about and convince somebody else, then it might come down more toward the bottom... (ORSH)

Communication—I almost think of it not so much as a foundation as the bridge. You do the others and that’s the thing that ties it together. It’s not that it’s fourth on the list, that it’s of the least importance. It’s the key that kind of comes after the others. (ORSH)

Communication—we felt it is necessary in being able to do reasoning, to discuss with others, to help identify problems. (ILSH)

(Communication)...but then we looked at it, we thought when was the last time I talked about how I made mathematical decisions. I can’t think of any...You know communication is important in almost any interview you do and any proposition that you write. You know, communication is important, so that is why we thought that would be important. But as we looked at it, we thought “no”, it is not something that you do that much. (ILSH)

Our reasoning behind this was we looked at communication as being the very basic, the very foundation. We didn’t think there could be any exchange of ideas if we couldn’t communicate, if we were speaking a different language or giving you high level math terms that you had no idea of a concept. So we thought communication was very important in being able to understand and making progress in learning basic skills, being able to understand the other things on the list. (ILSH)

Communication—ability to talk about math, to justify. (NESH)

**Whole Numbers**

Whole number computation, decimals, geometry, that is sort of what we called content skills, stuff you’ve got to know and we weren’t sure—we put one in—and the discussion went back and forth between whole numbers and fractions and decimals and algebra stuff. Is it 3 or 4? We finally said, “We’ll pick whole numbers and maybe move into reasoning.” The idea was we’re
limiting the set of skills that we said people might need to know by just mentioning whole numbers and not including the entire math spectrum. (ILSH)

Whole number computation patterns and relationships. (NESH)