DOCUMENT RESUME

ED 397 232 CE 071 992

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TITLE Adult Numeracy Instruction: A New Approach. Participant Packet.
INSTITUTION National Center on Adult Literacy, Philadelphia, PA.
SPONS AGENCY Office of Educational Research and Improvement (ED), Washington, DC.
PUB DATE Dec 94
CONTRACT R117Q00003
NOTE 62p.
AVAILABLE FROM National Center on Adult Literacy, Publications, 3910 Chestnut Street, Philadelphia, PA 19104-3111 (order no. PR94-04).
PUB TYPE Guides - Non-Classroom Use (055)

EDRS PRICE MF01/PC03 Plus Postage.
DESCRIPTORS Academic Standards; *Adult Literacy; Annotated Bibliographies; *Classroom Techniques; *Computer Uses in Education; Educational Change; Educational Strategies; Electronic Mail; Information Networks; Information Sources; Internet; Learning Activities; *Literacy Education; Mathematics Instruction; *Numeracy; Online Systems; Resource Materials; Teaching Methods; Teleconferencing; *Workplace Literacy
IDENTIFIERS Secretarys Comm on Achieving Necessary Skills; Video Teleconferencing

ABSTRACT

This document, which was developed for participants in a videoconference examining a new approach to adult numeracy instruction, contains information and resources to help literacy trainers improve their numeracy programs. Presented first are the following: 12 instructional goals/principles that are based on the premise that numeracy educators must not simply teach computation but must also consider cognitive and dispositional goals; suggestions for staff developers and program administrators; and 8 classroom activities demonstrating the proposed 4-phase instructional approach (building on informal math, supporting sense making, developing interpretive skills, using integrated tasks). The second section includes brief discussions of selected recent initiatives to improve mathematics education (National Council of Teachers of Mathematics initiatives and standards, the Secretary's Commission on Achieving Necessary Skills, a recent working conference on adult mathematical literacy, and the adult numeracy practitioner network) and a 22-item annotated bibliography of resource materials for/about adult numeracy. Section 3 explains how to join the Internet's electronic numeracy forum, describes key electronic forums/databases concerned with adult numeracy and literacy issues, and provides technical information regarding accessing electronic adult numeracy resources. Appended is a math problem illustrating the proposed approach to numeracy instruction. (MN)

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ADULT NUMERACY INSTRUCTION: A NEW APPROACH

DECEMBER 1, 1994

PARTICIPANT PACKET

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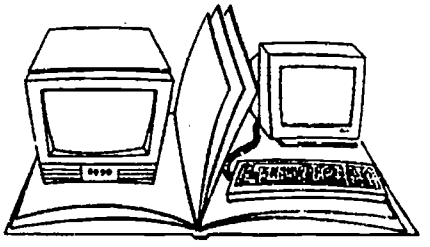

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ADULT NUMERACY INSTRUCTION: A NEW APPROACH

DECEMBER 1, 1994

PARTICIPANT PACKET

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This work was supported by funding from the National Center on Adult Literacy at the University of Pennsylvania, which is part of the Education Research and Development Center Program (Grant No. R117Q0003) as administered by the Office of Educational Research and Improvement, U.S. Department of Education, in cooperation with the Departments of Labor and Health and Human Services. The findings and opinions expressed here do not necessarily reflect the position or policies of the National Center on Adult Literacy, the Office of Educational Research and Improvement, or the U.S. Department of Education.

Please read first!

Welcome to *Adult Numeracy Instruction: A New Approach*

Dear Colleague:

Thank you for ordering materials from the videoconference *Adult Numeracy Instruction: A New Approach*, shown on Dec. 1, 1994 and downlinked by over 850 sites nationwide.

This packet contains a wealth of materials, including a list of instructional principles, sample classroom activities, suggestions for staff development, background information on reform trends, and lists of key printed and electronic resources on numeracy instruction. The videotape includes instructional demonstrations, panel discussions, and question-and-answer sections.

The videoconference aimed to illustrate and further discuss some, but not all, of the ideas discussed in the packet. The packet thus provides additional information and suggestions not covered in the broadcast. Both resources can be used in combination. For example:

- You can view the whole videotape first (no need to read the packet ahead of time). Take into account that during the broadcast, only some of the eight activities listed in the packet were demonstrated (Activities #1-4, and later on also Activity #8, which was called the Detective Problem). After viewing the videotape, you may want to read the packet for details about the activities and consider using some of the activities with students. (Materials for the Ice Cream Problem presented during the broadcast are included in the Appendix of the packet).
- If you plan to use the video with your students or as part of staff development, you may want to show only selected portions to generate discussion or focus attention on specific issues. Please see page i for specific suggestions on how to use the video.
- Some readers may prefer to read the Principles section in the packet first, to overview the "big ideas" that stand behind the specific activities described in the packet or demonstrated on tape. Many readers will also find it useful to read later sections in the packet, which describe recent reforms in mathematics education and ideas about needed workplace skills.
- Some teachers may prefer to try out a single activity from the packet first, before viewing the videotape or reading the packet. This can give educators a first hand experience and a feel for some of the ideas which are explained in the packet, but that become clearer when experienced in the classroom.

Please be aware that in developing the packet, the writing team was limited to no more than 50 pages, due to logistical limitations imposed by the need to ease distribution and copying of materials. The design of the broadcast likewise required decisions and compromises about what to include and what to exclude. While we have made efforts to cover many important issues, we recognize that a single broadcast or packet cannot be all things to all people and address the diverse needs and challenges in adult numeracy education. We are certain you will find additional issues that deserve attention, and we hope that the resources listed in the packet will enable you to find answers to questions you may have. Best wishes for productive work.

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December 1, 1994

Dear Videoconference Participants:

Welcome to the videoconference *Adult Numeracy Instruction: A New Approach.* We are pleased that you have decided to participate today and certainly hope that you will find the videoconference to be of value for you, your program, and of course, your students.

This is the second in a series of staff development videoconferences brought to you through a partnership among the National Center on Adult Literacy, the PBS Adult Learning Service, the Office of Vocational and Adult Education of the U.S. Department of Education, the National Institute for Literacy, the American Association of Community Colleges, and WHYY-TV in Philadelphia. Each of the partners has contributed important resources to the development and implementation of this project because of our commitment to addressing the important issues of adult literacy and numeracy.

The National Center on Adult Literacy is pleased to provide for you the Participant Materials Packet. It includes a great deal of useful information and resources that will enhance your participation in the videoconference and will assist you as you consider making changes in your numeracy curriculum and teaching strategies. We urge you to pay special attention to the follow-up electronic networking component of this videoconference, as this will allow you to continue the dialogue on adult numeracy issues.

At the close of the videoconference, please be sure to fill out the evaluation form that is in your packet and return it to your site coordinator. Your feedback is very important to us as we move forward in this videoconference series.

Sincerely,

Joyce Harvey-Morgan
Associate Director, NCAL

Iddo Gal
Numeracy Project Director, NCAL

The videoconference *Adult Numeracy Instruction: A New Approach* and its accompanying Participant Packet have been developed through the combined efforts of numerous individuals.

In planning the videoconference, the design team at NCAL (Joyce Harvey-Morgan, Iddo Gal, Paté Mahoney, Ashley Stoudt, & Lynda Ginsburg) has benefited from input from an advisory panel comprised of Patsy Byers (WA), Don Chao (CT), Susan Cowles (OR), Margaret Hamstead (NY), Myrna Manly (CA), Joe Sackett (NM), Mary Jane Schmitt (MA), and Jean Stephens (OH). Additional suggestions were made by Jerry Lord from the Office of Educational Research and Improvement of the U.S. Department of Education, Ron Pugsley and members of the Office of Vocational and Adult Education of the U.S. Department of Education, and by Michael Fragale from PBS Adult Learning Service.

The Participant Packet for the videoconference was written by Iddo Gal, Lynda Ginsburg, Ashley Stoudt, Karl Rethemeyer, and Caroline Brayer Ebby (NCAL). Editing and layout of this complex document were done by Joyce Harvey-Morgan, Paté Mahoney, and Janet Smith (NCAL).

The writing team thanks Esther Leonelli (MA) and Alycia Donohoe (NCAL) for providing technical information about electronic resources on mathematics and numeracy education, and Caroline Brayer Ebby (NCAL), Mary Jane Schmitt (MA), Myrna Manly (CA), and Susan Cowles (OR) for comments and suggestions on earlier drafts of the Participant Packet.

A special thanks to our videoconference team teachers, Susan Cowles, Instruction and Staff Trainer from Linn-Benton Community College in Albany, OR and Patsy Byers, Staff Development Trainer from the ABLE Network in Seattle, WA.

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Adult Numeracy Instruction: A New Approach

Videotape Contents

1.	Opening Montage *(about 4 minutes)*	What learning math means to diverse students and teachers; past experiences in school; why knowing math is relevant.
2.	Live Classroom I *(about 16 minutes)*	Exploring the role of percents in real life. Introducing the Ice Cream Problem to students.
3.	Pre-Taped Segment *(about 15 minutes)*	Making sense of statements with percents. Visualizing percents.
4.	Live Classroom II *(about 17 minutes)*	Students and teachers work on and discuss the Ice Cream Problem. Discussion focuses on students' informal knowledge, sense-making, linking numeracy to literacy instruction, using integrated tasks, preferred learning modes.
5.	The Detective Problem *(about 8 minutes)*	Showing a problem for the viewing audience to think about. (Problem is presented, then text is on screen for 5 minutes.)
6.	Panel and Call-In *(about 50 minutes)*	Panelists discuss questions from viewers and discuss issues such as needed skills, needed changes in teaching methods, and staff development.
7.	Final Suggestions *(about 7 minutes)*	Local action; resources; how to join electronic networks and exchange ideas with other teachers; using the packet.
8.	Closing	Final remarks; credits.

How to Use the Videotape

You may want to consider using selected portions of the videotape as "discussion starters" for either teachers (as part of staff development) or students. For example:

- View the opening montage and have students or teachers discuss (e.g., experiences from their own schooling in math; influence of prior experiences on their beliefs about the value/teaching/learning of mathematics and on their self-concept as mathematical problem solvers; or motivations to invest in teaching and learning mathematics).
- Show the segment introducing the Ice Cream Problem. Provide materials for the problem (see Appendix). Have students (or teachers) work on it for 20-40 minutes and then discuss. Show Segment #4, showing students discussing their approaches. Have a follow-up reflection with students and teachers.
- Have students or teachers view the pre-taped segment (#3 above) and reflect upon students' statements at the end of each segment (e.g., the role of visual vs. procedural approaches to learning, the value of group work).
- Show the Detective Problem. Have students or teachers work for 15-30 minutes and then discuss. Then view the first 15 minutes of Segment #6, where "solutions" to the Detective Problem were discussed. Note that the Detective Problem is covered more thoroughly as Activity #8 in this packet.
- You may want to stop the videotape at any point where a question or dilemma is posed (e.g., during call-in periods, as part of panel discussion) in order to start a dialogue.

See additional suggestions in the "Please Read First!" opening page.

Adult Numeracy Instruction: A New Approach

Participant Packet Contents

How to Use the Packet

This packet has three main parts.

- *Part A* (the longest) introduces twelve instructional principles that can inform changes in teaching practices in adult numeracy education (Section 1), followed by some suggestions for staff development (Section 2) and by eight classroom activities that demonstrate how the principles can be implemented in the classroom (Section 3). (Some readers may prefer to start from the general principles and then go into the examples, while others may start from examples and then go back into the general ideas behind them.)
- *Part B* includes several short sections with brief summaries of recent work and key publications that should be consulted, and information about the National Adult Numeracy Practitioner Network. It also lists key math and numeracy resources (books, activity collections, videos, tutor handbooks) that can be used to implement or support suggested changes in numeracy instruction.
- *Part C* explains how to join the electronic NUMERACY forum on the Internet in order to follow up and discuss ideas presented during the videoconference. It also describes key electronic forums or databases addressing adult numeracy and literacy issues and provides technical information on how to access such resources.

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Adult Numeracy Instruction: A New Approach

Part A: Instructional Principles and Suggested Activities

Section 1. Instructional Goals and Principles

Just as we believe that literacy education encompasses much more than teaching decoding skills, so numeracy education encompasses much more than teaching computation.

This section aims to promote a dialogue and inform decisions (by teachers, students, and programs) about the goals and methods of adult numeracy education. A selected set of curricular goals is introduced, followed by a discussion of instructional principles. The ideas discussed in this section were derived from recommendations and writings by numerous groups concerned with improving mathematics education, as well as from the research and experiences of members of the Numeracy Project of the National Center on Adult Literacy. For a more extensive discussion of these and other important principles and suggestions, please consult the "Selected Math and Numeracy Resources" section in this packet.

I. What Should Be Taught?

In considering the goals for numeracy instruction in the context of your program, you may want to think about the following interrelated questions:

1. *What math/numeracy skills are important for adults to possess?*
2. *What else besides computational skills do people need to know or possess in order to effectively deal with real-life quantitative problems and be considered numerate?*

It is not possible to provide a single response to these questions that will apply to all classrooms and students. Students bring to the classroom diverse experiences and a range of cultural, linguistic, and mathematical knowledge; furthermore, students and teachers have multiple goals (e.g., improving functional skills, upgrading job-specific competencies, preparing for further "academic" learning of mathematics, passing a critical test), each of which may dictate a somewhat different set of curricular objectives and classroom practices. We urge readers to consider both the "cognitive" and "dispositional" goals of numeracy instruction. By cognitive goals, we mean the skills and knowledge that we would expect learners to be able to develop and apply in various life, work, and school situations. Equally important, however, are the dispositional goals—the beliefs, attitudes, and "habits of mind"—that learners need to develop in relation to their growing knowledge and skills. The specific elements of these interrelated goals for instruction are described below.

Cognitive Goals

Most educators would likely agree that adult students should develop some knowledge in specific key areas of mathematics. Areas on which adult math instruction has traditionally tended to focus include mainly number operations, measurement, basic geometry, basic algebra, and some graphing and charting.

While the areas mentioned above continue to be important aspects of "core mathematical knowledge," there are several other critical topics that need more development in adult numeracy instruction. These additional topics include (a) number and operation *sense*, (b) estimation and "mental math" skills, (c) being able to make judicious use of calculators to ease computations, (d) statistical literacy (i.e., ability to interpret critically and become selective in relying on statistical information one may come across, as in newspaper articles or advertisements), (e) skills needed to handle functional tasks involving numbers embedded in text (e.g., comprehending or acting upon forms, schedules, and technical and financial documents), and (f) skills needed to plan and optimize the use of resources at home or at work (e.g., budgeting, scheduling, and managing supplies).

Most of the additional skill areas are necessary for adults to function effectively in many everyday and work-related situations, and they should be included in the definition of "core knowledge" as emphasized in adult numeracy instruction, even if they do not seem to fit neatly into traditional definitions of content areas in mathematics.

It is important to pay more attention to the *interpretive* skills that adults need to make sense of text-rich stimuli (e.g., newspaper articles) that touch on quantitative issues but that do not involve direct manipulation of numbers. When teaching statistics, for example, instruction usually focuses on producing bar graphs or pie charts, ignoring broader critical issues such as sampling, variability, error in measurement, and inference from evidence. Text comprehension and vocabulary skills should also

be emphasized if we expect to develop students' statistical literacy, and their ability to make sense of statements in the media.

Lastly, cognitive goals should not only include mastery of the separate skill areas listed above. Our ultimate goal should be to develop broad problem-solving, reasoning, communication, planning, and self-monitoring skills so that all students can approach, analyze, and effectively handle diverse situations with embedded mathematical (or quantifiable) elements.

Dispositional Goals

Curricular goals for adult numeracy education must also address students' dispositions, self-concepts, beliefs about the relevance of mathematics to real-life, and expectations about what learning and knowing mathematics should encompass.

Some adults who come to literacy programs, as well as many others who do not, report negative attitudes about learning math or addressing everyday mathematical tasks. These feelings are usually attributed to negative experiences they had as students in K-12 schools, and these attitudes frequently interfere with the students' motivation to develop new mathematical skills.

Showing students that "math is fun" (e.g., by using math games) may be of some help in reversing their negative feelings about school math, but may not be sufficient to cause students to change their habitual approaches to real-life situations that involve mathematical elements. Adults with negative dispositions may have long-standing habits such as electing to avoid numerical tasks, trying to handle tasks through informal (and possibly less efficient and accurate) methods, or depending heavily on assistance from others (e.g., a family member, a salesperson). We hope that such practices will be changed as a result of numeracy education.

Adult numeracy education should help students develop positive beliefs in their own mathematical power, as well as in the contribution of mathematical (as opposed to nonmathematical) reasoning to real-world functioning and effectiveness. Achievement of these goals is critical if we hope to see adult students continuing to invest in further learning of mathematics.

II. How Should We Teach Math and Develop Numeracy Skills?

Many adult education programs subscribe to the notions that (a) learning is a social activity, (b) learners should participate in defining what is important to learn, (c) the usefulness of learned skills or knowledge should be apparent to adult learners, and (d) learned knowledge should be an outgrowth of what is already known to learners.

However, many adult educators may not apply these notions to math education as easily as they do to literacy activities. Often they use a much more limited repertoire of teaching methods when teaching numeracy than when teaching literacy. This situation may be due in part to the lack of available preservice and in-service workshops on effective frameworks for learning and teaching math, to teachers' resulting reliance on their own school experiences learning math as a model for teaching, and to learners' expectations of what a math class should look like.

Below are listed 12 separate but related principles and suggestions that can assist educators in planning classroom activities. Section 3 presents sample classroom activities to further illustrate how such general ideas can guide instruction, Section 8, "Selected Math and Numeracy Resources," lists additional sources that offer ideas for implementing these and other principles in practice.

1. Determine what learners already know about a topic before instruction.

Rationale: Adult students have a rich background of real-life experiences. Even if they have learned little formal math, they are likely to have engaged in counting, sorting, measuring, playing games of chance, and, most importantly, handling money. Through such experiences, adults most likely have developed various skills and their own (partially) formulated conceptual understandings, some correct and some incorrect. New learning will be filtered through or have to be integrated with prior knowledge. Each learner's informal knowledge should be identified and validated so that new instruction can be designed to link with what already has meaning to the learner. At the same time, attention must also be paid to incorrect ideas or patchy knowledge so that these do not distort new learning or cause the learner confusion.

Suggestions: Start a new topic with an informal discussion of learners' real-world and school experiences as well as "what do we know already?" in the new area of instruction. This gives learners opportunities to think about and discuss mathematical issues and begin

linking bits of unconnected information into a structure without the competing demands of computation. A computation pretest should not be used as a primary source of information. Besides producing anxiety for the learner, it reinforces a sense that mathematical tasks involve only computation. In addition, such tests rarely provide teachers with much information on a learner's underlying thinking processes.

2. Address and evaluate attitudes and beliefs regarding both learning math and using math.

Rationale: Many learners come to the classroom with fears about their own abilities in the area of math ("I can't do math," "I can't remember how to do math even though I've learned it so many times," etc.). In addition, learners often carry with them nonproductive beliefs about what it means to "know math" or what learning math should look like ("there is always only one correct answer," "there is one right way to solve problems," "you should always work alone on math problems," etc.). These negative attitudes and beliefs often hold learners back from engaging in math tasks in meaningful ways and from trusting their own mathematical intuitions. Limiting self-images and beliefs are particularly harmful because learners may inadvertently communicate them to their own children.

Suggestions: It is important to discuss openly with learners the reasons why traditional K-12 methods of teaching math may have engendered negative beliefs and attitudes; otherwise, some learners may continue to direct blame at themselves and may not approach classroom-based as well as real-world mathematical tasks in a productive way. Have learners freely talk or write in a trusting environment about their attitudes and beliefs, sharing your own fears and experiences. Point out and inspire learners to look for manifestations of their existing (even if informal) mathematical understandings, which they may be unaware of, to encourage the development of feelings of comfort and control. This process of exploration and reflection should occur throughout instruction, not only at the outset, since negative attitudes and beliefs may be tied to certain areas of the curriculum.

3. Develop understanding by providing opportunities to explore mathematical ideas with concrete or visual representations and hands-on activities.

Rationale: Learners will find the math they are learning more meaningful if they can link the ideas, procedures, and concepts to realistic situations and concrete representations. Guided experiences using concrete objects or visual displays help learners "see" and "feel" the reasons for computational algorithms and provide backup strategies that can support learning. Being able to create a physical model enables learners to visualize the concrete reality underlying abstract symbols and processes and helps learners monitor their own computations and understanding.

Suggestions: At the beginning of a new unit, have students solve a number of related problems using real objects. Encourage learners to talk about these examples and explain what observations they can make. After learners are comfortable with new concepts in a concrete context, a discussion generalizing and formulating more abstract principles is appropriate. Have learners perform mathematical operations on a representative model of a situation and move between "real objects" (e.g., apples, coins, cups),"representative objects" that can stand for real objects (e.g., blocks, toothpicks, beans), and numbers. (Many commercial publishers sell "manipulatives" such as pattern blocks, base ten blocks, fraction circles, Cuisenaire rods, geoboards, etc., for use as representative objects in teaching specific topics. Transparent versions of these objects are available as well for use with an overhead projector, and can greatly help in demonstrating work with manipulatives to groups of learners.)

4. Encourage the development and practice of estimation skills.

Rationale: Many everyday or work tasks do not require precise, computed answers, but rather quick approximations. When shopping, it is often more reasonable to approximate a total cost mentally instead of using a calculator or doing a written computation to confirm that the price at the cash register is correct. Computing a 15% tip does not have to be precise yet can be an overwhelming task to someone who can only calculate percentages by using a formula. Generating quick, approximate answers to math questions on standardized tests is often sufficient to discount all but one or two of the response choices. (Some questions

on the GED math test expect students to use estimation, not exact computations.) Good estimation skills can also be used to catch gross computational errors such as from misplaced decimal points or from errors in using a calculator.

Suggestions: Identify and discuss times when estimates are more appropriate than exact answers, reinforcing the notion that estimating is a valuable skill, not merely something you do when you don't know how to figure it out the "right" way. Encourage learners to share with each other the estimation strategies they use (such as "multiplying by 10 instead of 9 and then subtracting a little"), and supplement the class repertoire with strategies that you use in your everyday life. Stress that there are no "right" or "wrong" estimates, only ones that are closer or farther from a computed answer, and that the importance of the degree of exactness depends on the requirements of the situation. For practice, students can be asked to estimate answers before they are computed.

5. Emphasize the use of "mental math" and the need to connect different mathematical skills and concepts.

Rationale: Doing mental math often involves performing various operations quite differently from school-based, written procedures in order to achieve essentially the same goals. (Ask your students and colleagues *how* they add 15 to 27 in their head, and *why* they do it differently than on paper.) As some students are fearful or uncomfortable with doing mental math ("This is not the real math I learned in school"), such skills must be practiced over time in numerous situations so that learners will trust their abilities enough to use them when appropriate.

Mental math relies on a facility for moving between equivalent representations of quantities and on understanding of the implicit connections between procedures. That facility requires an understanding of how and why procedures work and an expectation that there are meaningful connections between concepts. Traditionally, we have assumed that learners will intuitively make connections between the different topics encompassed in math classes, but in fact learners often think of them as self-contained units. This view of math as a series of discrete and unrelated topics is reinforced by individual "topic" workbooks (such as "fractions"). Learners who "expect" connections between different mathematical concepts will also be less fearful of math since they will expect new mathematical learning to be an extension of what they already understand.

Suggestions: Refer frequently to previously studied material to help learners see the connections between different mathematical concepts, such as fractions, decimals, and percents, so that learners become flexible switching from one "system" to another when performing "mental math" (for example, 25% is one fourth, so divide by four). It is important that learners are able to discuss and demonstrate their understanding of the differences and similarities between what they figure out in their heads and what they are learning in class, and that they develop a repertoire of mental math strategies with which they feel comfortable. Discuss "why" you can get the same answer using different computational procedures or representations and elicit opinions about the relative advantages of one representation or mental or written procedure over another.

6. View computation as a tool for problem solving, not an end in itself; encourage use of multiple solution strategies.

Rationale: While computational skills are important, students should also develop the ability to determine *when* certain computations are appropriate and *why*. We must balance time spent mastering computational skills with time spent talking about and exploring the applications of computations and enable students to use their skills in new situations.

Suggestions: Frequently ask learners *why* they did what they did and what else they could do. Develop computational algorithms logically so learners see that the algorithms are simply shortcuts for time-consuming procedures (such as multiplication for repeated addition and division for repeated subtraction). Discourage memorizing rules without understanding the meaning because this often leads to inappropriate or incomplete application of procedures and to meaningless answers. The bottom line is that learners should come to view the different graphical or computational techniques they know as tools for problem solving, not as ends unto themselves. For this to happen, tasks used in class should

involve real problem solving (where students have to choose what skills to use), not just repetitive computations.

7. Develop learners' calculator skills and foster familiarity with computer technology.

Rationale: These days, much computation can be done with the use of inexpensive calculators. Although calculators may take the place of tedious computation and ensure accuracy, they do not replace deep understanding of mathematical concepts and procedures, and they cannot make decisions related to problem solving. It is becoming ever more important to know *what* a procedure does, *why* it works, and *how* the results can be evaluated to make certain they are appropriate responses to the original task. Consequently there is less need for knowing *how to do* fast calculations by hand given the availability of calculators.

Calculators can be used as an instructional tool; learners can quickly observe the results of many calculations, see patterns, make generalizations about mathematical processes, and focus on understanding without getting bogged down in lengthy calculations. This is not to say that calculators should replace computation skills, but that the goals of adult numeracy education will be enhanced by encouraging judicious calculator usage. Students will thus become skilled at using what has become an essential workplace tool.

Suggestions: Provide opportunities to use calculators and set aside time to make certain that each person knows how to use his/her calculator. Use calculators to check mental math after establishing a basic conceptual understanding. Give students a problem that depends on finding a computation pattern, such as "When you add two even numbers, is the answer always even? What happens when you add two odd numbers? One even and one odd?" Encourage students to keep records of their experiments and then draw conclusions.

Explore the possibility of using computers with math education software to help students develop specific mathematical skills, but keep in mind that computer usage should be integrated with other classroom activities and needs to be accompanied by classroom discussions. Encourage students to use word processing or simple "integrated" software (with graphing, database, or spreadsheet capabilities) as an aid in planning, managing, and presenting results of group projects (timetables, attendance lists, graphs, conclusions, activity logs). Overall, such practices should enrich student experiences with literacy-numeracy connections and help them integrate their skills; printouts should find their way into students' portfolios. (We realize that many programs do not have much computer equipment and may not provide teachers with much training; yet, some goals must be established in this area, even if the beginning is very humble.)

8. Provide opportunities for group work.

Rationale: The SCANS commission (see Section 5) suggests that those joining the workforce must be competent in working with others on teams, teaching others, and negotiating (e.g., over acceptability of a proposed solution to a problem). These skills should be developed in multiple contexts, including when solving problems involving numerical information. Traditionally, math has been studied alone and communal work was relegated to other disciplines such as science or social studies. Yet in the real world, people regularly have to communicate about numerical issues (negotiating a contract, making business or purchasing decisions, etc.). Furthermore, students often benefit from their peers' observations or explanations because one student may be able to identify another student's point of confusion or explain a concept with examples that are especially helpful for that particular student.

Suggestions: Create an atmosphere in which learners frequently have to work together and help or teach each other. Periodically introduce large, realistic projects for which heterogeneous and extended group efforts are appropriate, such as organizing a group trip or spaghetti party (including planning, deciding on and managing schedules, budget, supplies, materials, division of labor, etc.), or conducting a survey about a meaningful issue (including collecting, analyzing, and reporting on findings and implications). It is difficult to expect students to develop realistic group work skills in the context of isolated, brief tasks of the kind espoused in textbooks.

9. Link numeracy and literacy instruction by providing opportunities for students to communicate about math.

Rationale: Many workplace and real-world situations require individuals to not only solve mathematical problems, but also to communicate their reasoning and the results or implications of their work to others. Adults also frequently find themselves discussing mathematical concepts with their school-aged children as they help with homework assignments or studying for tests. Communicating mathematically might include drawing a diagram (of a room to plan carpeting), writing a letter about an error on a utility bill, calling someone to report that a shipment arrived with less than the ordered amount, or negotiating terms of a sale, and so forth. Thus, reading, writing, and communicating are activities within which math is found and should be taught and practiced with mathematical content. "Talking about math," whether verbally, diagrammatically, or in written form, forces learners to clarify and structure their thinking so that a target audience will clearly understand their information or argument.

Suggestions: As students work on math, encourage them to explain to others what they are doing and why. Journals enable students to reflect on and describe successes and points of confusion to themselves and their teacher. Extend activities to encompass a range of literacy experiences and the creation of literary products, including writing letters of complaint to companies clearly detailing billing problems; writing a letter to the editor of a newspaper or magazine, or to the chair of a civic group explaining an opinion based in part on some numerical information; writing word problems or more extended math stories for others in the class to solve; or writing a detailed explanation of how and why some mathematical procedure is used, which could then be saved to create a "resource book" for the class or the individual learner.

Verbal communication skills can be developed by presenting problems to the class that do not dictate a single solution process or lead to a single right-or-wrong answer (such as "How can we measure the area of an irregularly-shaped lake?) and by giving students opportunities to present and discuss possible solutions. Alternatively, encourage students to conduct a survey and present results verbally and with visuals to the class.

10. Situate problem-solving tasks within familiar, meaningful, realistic contexts in order to facilitate transfer of learning.

Rationale: Educators hope that the skills they work on with students will be used effectively and appropriately in out-of-school environments. Unfortunately, researchers have found that skills learned in one environment are not easily transferred to or applied effectively within another environment. The farther the learning context is from the target context, the less likely it is that transfer will occur. It is thus important that learners practice using their new skills in environments that are very similar to target environments in which they will have to function, rather than just in context-free environments such as workbooks with extensive isolated arithmetic practice exercises. In addition, interest in learning will be sustained if the students can see clearly that what they are learning will be directly applicable to situations in their own lives.

Suggestions: Elicit learners' experiences in which mathematical issues arise to develop meaningful, realistic contexts for problem-solving tasks. The mathematical content should also be appropriate for what one would actually want to know in a particular context (for example, computing and comparing the price per ounce of the same cereal available in small and large quantity boxes is appropriate and useful; finding the average price of 6 items in a grocery cart is not meaningful or useful). Students can also be asked to role play real-world situations in the classroom.

11. Develop learners' skills in interpreting numerical or graphical information appearing within documents and text.

Rationale: Numerical information is often embedded in text or is encountered in literacy-rich contexts such as statements of employee benefits, payment schedules, and maintenance agreements. People often read newspapers or magazines and have to interpret graphs or statistical information presented in tables or text. Most often there is little or no computation to do, only a need to apply conceptual understanding. Yet if adults skip pertinent numerical information because they feel uncomfortable or incompetent about

processing it, the text loses meaning and people lose access to critical information. The goals of both numeracy and literacy instruction will be most effectively met when we help students develop number sense, statistical literacy, and interpretive skills.

Suggestions: Individual students could bring in and read newspaper articles or other text-rich materials containing numerical information that must be interpreted but not necessarily "computed" and report a summary of that information orally or in writing to other students. Alternatively, all students in one class could read the same article and discuss implications. Work with students on vocabulary and comprehension of technical terms.

12. Assess a broad range of skills, reasoning processes, and dispositions, using diverse methods

Rationale: Educators communicate their pedagogical priorities to students in part through the assessments they use. Many adult education programs use multiple-choice tests such as the TABE to evaluate the mathematical skills of incoming students or to assess learning gains. By using *only* such tests, we communicate that what we value in numeracy education is mostly the ability to compute with decontextualized numbers or solve brief (and sometimes contrived) word problems. Yet, if we accept the curricular goals and instructional principles discussed above, we should also significantly extend the scope and methods of assessments used in adult numeracy education.

Teachers should make sure that assessments focus on worthwhile content that reflects the instructional goals of the students' program of studies. Problems used in assessments should yield information that can provide meaningful feedback to the student, as well as inform instructional decisions by the teacher. In addition to mastery of computations and formal procedures, assessments should encompass the many additional skill and knowledge areas that are part of "being numerate," such as interpreting statistical and quantitative claims, acting upon numerical information in technical documents and forms, applying mathematical reasoning and solving realistic problems, communicating about mathematical issues and explaining one's reasoning, and so forth.

Suggestions: Mathematics assessments should extend well beyond examining students' ability to find the right answer for a computational problem. They should also include problems that have multiple correct or reasonable answers, as well as tasks that require extended work (rather than a quick answer) and culminate in diverse products. Such products may include graphs, tables, drawings, written text or oral reports describing a solution process (of an individual or a group), a written recommendation for a course of action, memos aiming to communicate about mathematical issues with specific real-world audiences (and demonstrating both appropriate mathematical know-how and literacy skills), or performance on simulations of real-world activities.

By expanding the notion of what constitutes "assessment," educators can blur the lines between assessment and teaching, and use teaching activities also to generate information that can satisfy both diagnostic and evaluative needs. To the extent that teachers and students together find such information of value, representative samples of work can be recorded and stored for various uses. Unless assessment information is put to good and timely use by teachers and students, time spent on assessment is wasted and learning is not helped. Many recent publications have addressed the issues of meaningful math assessment or have provided pragmatic recommendations for teachers and administrators. A few of these publications are listed in the resources section below, but many other valuable resources on assessment are available and should be consulted.

Summary: Adopt a "whole math" approach.

Rationale: Typically, the solution of problems within a math class relies only to a limited extent on generalized problem-solving, reasoning, and communication skills. All too often, students work on one skill at a time and are told what algorithms to apply to contrived problems (e.g., "do all fraction problems on this page"). However, in real-life contexts quantitative or quantifiable elements or issues may be interspersed with other information, and it is

seldom specified what to do or what knowledge is relevant. People have to *comprehend* a situation, *decide* what to do, and *choose* the right tool(s) from their "mathematical tool chest" that will enable them to reach a *reasonable* solution. For this to happen, students have to rely on generalized problem-solving, reasoning, and literacy skills, drawing upon whatever specific mathematical content knowledge they may have, as well as upon other kinds of knowledge.

Suggestions: Instruction should make sure to focus on both "stand-alone" skills and integrated problem solving. Engage students in the problem-solving process and allow them to struggle with solutions. This can help students gain the skills and dispositions needed to apply their numeracy skills appropriately in other problem contexts, as well as develop or practice "component skills" in a meaningful context. This educational emphasis requires that teachers reevaluate and redefine their roles within both the classroom and the educational process (see the section "Taking Steps To Change Instructional Practices" for a discussion of this issue).

Section 2. Taking Steps To Change Instructional Practices

The principles and sample activities described in this packet present a somewhat different vision for adult numeracy education than the one currently practiced by many teachers. In considering ways for incorporating some of these ideas in your practice, it may help to keep in mind the following:

- Changing your instructional practices is a gradual process of investigation. Decide on one or two new principles or activities that you want to begin to explore, and try them out for a while. Allow time for your own reflection and self-assessment as your instructional practices shift; you may want to consider keeping a teaching journal. Change takes time, and finding what works in your classroom requires periodic review.
- It is often difficult to encounter challenges and reflect on change by yourself. Seek a partner with whom you can exchange ideas and get broader perspectives. Tell your learners you are trying some new ideas and ask them for feedback.
- Be prepared to reconsider your own and the learners' roles in the classroom. An important role for you to play is to *model your own problem-solving and reasoning process* (e.g., think aloud how you plan to handle a new problem, how you try to get out of an unproductive solution, how you reread instructions, etc.). In this way, you can demonstrate some of the dispositions involved in numerate thinking. As students begin to work on new and increasingly more complex problems or projects (some of which you may have never done before), you may find yourself serving as a facilitator and mentor, rather than as the sole source of knowledge in the classroom.
- Actively seek support from your colleagues and administrators, whether it is for sharing insights and concerns, arranging for mentoring, or making resources available. Let them know that you are going to try new things to enhance teaching and learning.
- Attend regional NCTM conferences, or those of state affiliates; contact the local school system or the math education department of local colleges about math workshops, especially for middle school teachers. Many reform efforts in K-12 math education can be adapted to adult education. Contact your State Literacy Resource Center.

Suggestions for Staff Developers and Program Administrators

- Expecting teachers to consider new ways of instruction entails providing a supportive environment in which teachers can *experiment* with their teaching and reflect on their own learning. Teachers need to be encouraged and ready to take risks. Provide teachers with opportunities to explore their experiences and beliefs about what learning and teaching mathematics should involve. Teachers need opportunities to discuss with colleagues and administrators their ongoing investigations into instructional change.
- Research conducted by the National Center on Teacher Learning shows that "one-shot" and brief (e.g., one-day) teacher training workshops are ineffective for creating long-term change in teaching practices. Instead, use your program's resources to support an ongoing, long-term change process. Do not expect quick fixes.
- Collaborative teacher groups can offer a productive context for reflection, sharing of ideas, and professional development. Here are some examples of what various groups have done.
  - An inquiry group in Philadelphia alternated between open-agenda meetings to discuss participants' ongoing activities, and focused meetings with discussions of specific instructional topics. Participants prepared for these discussions with background readings.
  - A study circle in Syracuse, New York chose to spend several meetings on the topic of math anxiety, what causes it, and how to address it.
  - A math team in Massachusetts conducted an inquiry-based research project in which each participating adult literacy practitioner implemented one of the NCTM standards in his or her classroom, collected data on the results, and reported and published the findings.

  (For more information on inquiry-based practitioner research in literacy programs, contact the NCAL Dissemination Office for a list of publications.)
- All of the above suggestions imply that we need to rethink the "training culture" in adult literacy education in general. Since numeracy and literacy instruction are interrelated and should be integrated, staff development should also be approached in an integrated manner.

Section 3. Classroom Activities: Putting Principles Into Action

Introduction

This section illustrates ways to implement some of the instructional principles discussed in the previous section. To maintain continuity, all activities address a single topic. We chose to focus on the teaching of *percents* because (a) understanding of percent is critical for effective functioning in many everyday and workplace contexts, (b) many students have difficulty with percents, and (c) many instructors may be unsure how to enrich percent instruction beyond the computational approach presented in most textbooks.

Four phases of instruction are discussed:

1. Building on informal math
2. Supporting sense making
3. Developing interpretive skills
4. Using integrated tasks

For each phase, two sample activities are presented. The introduction of formal methods for calculating percents (such as those presented in most math textbooks) should start after most or all of the second phase, "supporting sense making," is completed. Focusing instruction only on formal computations without enveloping that learning in additional experiences such as those described here will result in incomplete knowledge of percents.

All activities are predicated on the use of *extended communicative acts*. Throughout, students are encouraged to state, explain, and communicate (orally or in writing) their points of view, defend their reasoning, and listen to and challenge (if needed) other people's assertions. Such experiences have the potential to infuse more meaning into the process of learning mathematical skills and concepts as well as to contribute to the development of students' literacy and critical thinking skills.

Since only sample activities are presented, readers are encouraged to modify them and add additional activities so as to be able to implement as many as possible of the instructional principles discussed in Section 1. (Some readers may want to first read about these principles before exploring the activities below.)

I. Building on Informal Math

Numeracy education must build upon that which students already know, and expand that knowledge in meaningful ways. Adults encounter percents daily, but often possess a mix of informal skills and patchy formal knowledge in this area. The activities proposed below serve to enhance both *assessment* of this knowledge and student *learning* by (a) enabling teachers to assess the depth of understanding and the nature of informal skills and dispositions that students bring to their study of percents, *before* teaching "how to do" percents; and (b) enabling adult students to start a new topic without the inhibiting factor of computations and to see that they know more than they believe they know in an area considered difficult. Through these informal activities, students can reinforce "rusty" math knowledge, establish connections between ideas, boost confidence, and at the same time enhance literacy skills.

Activity 1. Do these statements make sense?

Purpose

Students discuss the reasonableness of different percent-related statements. This activity is designed to assess informal knowledge of percents and engage students (including those who think they "do not know how to do percents") in a meaningful, yet noncomputational discussion about percents.

What to do

1. Print a list of statements such as those below for each student. Ask the students to respond to the first statement and arrange a classroom discussion to model a productive dialogue.
2. Divide the class into groups of 2-4 students. Ask each group to discuss the questions posed after each statement and reach a consensus, rotating the tasks of leading the discussion and recording the group opinion and the arguments raised. Ask those who recorded the discussion of a given statement to summarize group opinions and then have a general discussion.
3. Encourage group dialogue. Everybody should ask, "Can you explain?" and "What is your reasoning?" Students should realize that there is no "right" answer to any statement. Accept a range of different opinions as "reasonable," but help students recognize not only strong or reasonable arguments, but also omissions ("what about . . .") or assumptions that are more shaky. Note that some students may know key "percent words" (i.e., 100% means the whole thing, 50% is a half), but have trouble with other percents; this could indicate that these students do not fully understand the underlying idea of percent as a proportional relationship.

Sample statements

Retype with 4-6 lines after each, for student responses. Feel free to change these statements, making sure new statements are phrased in an open-ended way to invoke responses of different qualities rather than a single right answer, and that the chosen contexts tap students' everyday knowledge.

1. A bus driver says that her bus arrives on schedule 100% of the time. How much sense does this make? Explain.
2. The local burger place advertises two new "great-tasting" milkshakes, one having 50% fat and the other having 0.5% fat. Which one would you prefer? Explain.
3. Vivian claims that 50% of the customers who bought baseball mitts today in the sport store where she works were left handed. How much sense does this make? Explain.
4. Sears is selling a coat at 20% off the regular price. At BestMart, the same coat sells for 1/4 off. Where will you shop? Explain.

5. Ben asks Jerry to loan him $100 for a week. Jerry agrees, but asks Ben to pay 25% interest at the end of the week. How good a deal is this for Jerry? For Ben? Explain.
6. Residents in Anytown (pop. 10,000) complain that the local post office is inefficient. The post office manager refutes the complaint, arguing that during the last 6 months only 5% of the local outgoing mail was sent to incorrect destinations or was overly delayed. How strong is the residents' case? Explain.

Concepts and connections to emphasize

Highlight these and related ideas as they come up in discussion (students may express the same idea in different ways):

- ➢ Percents express the size of an amount compared to a base of 100.
- ➢ Percents are alternative representations to fractions.
- ➢ Reference to a base quantity is sometimes necessary to make sense of percents.
- ➢ Percents enable a comparison of the relative size of different "things," which may have a different number of units or elements.

While this activity officially focuses on percents, a diverse set of other important topics will (or should) come up, such as proportional reasoning (e.g., relationship between percents, decimals, and fractions), financial literacy (e.g., what is "interest"), statistical literacy (e.g., frequency of certain phenomena in the world, there is "variation" in the world, conjectures can fluctuate if based on data from a small or a single sample), knowledge in other domains (e.g., science, social studies), and more. Emphasize the relatedness of concepts and knowledge across domains.

Extensions

1. Have students generate their own statements, based on information or percents found in newspapers, advertisements, or text in GED practice tests in science or social studies. They could write these up, publish, exchange with other students, and discuss reasonableness.
2. Much later, to bring in computational issues, encourage students to "run" different "models" of a situation to see patterns in the data and to help in forming opinions. For example, in statement #4, assume four different base prices for the coat and make a table with the resulting differences in actual price between the two vendors; in statement #6, make different estimates for the number of letters that residents in Anytown mail in a year, and derive the actual number of mailing problems that particular residents might encounter.

Activity 2. Real-life situations in which I encounter percents.

Purpose

To enable students to identify various contexts in which they encounter percents and to motivate formal learning about percents by establishing their importance in real life. Also, to open a window into students' actual *practices* and *problem-solving processes* when facing or handling percents outside the classroom.

What to do

1. Ask students to answer the following questions on a piece of paper:
   (a) Describe three instances or situations in which you recently encountered percents and, if possible, write the actual percent that was involved.
   (b) For one situation in which you had to figure out a value based on a percent, explain what you did (or what went through you head) as you faced the situation.
2. Ask students to read their three descriptions aloud. Record the different situations on a board. Make another list of the different ways students presently (before studying percents) approach percent tasks; discuss students' opinions on the relative merits of alternative strategies.
3. Post the list of the different percent-laden situations described so they can be referenced and used later on during percent instruction as evidence of real-world connections and for use as problem contexts.

Concepts and connections to emphasize

For each percent situation, discuss whether estimates or exact computations are appropriate, when, and why. Highlight that some involve computations but others approximations, some call for interpretation (not a numerical value), and some involve a combination of text and numbers. Discuss implications for skills that people need to develop. See this section for Activity 1 for more comments on key concepts and connections to be sought.

Extensions

The situations and behaviors that students described can be used later for numerous purposes, such as practice in mental math and computations, or for the introduction of calculators.

II. Supporting Sense Making: Using Visual Representations and Mental Math

When teaching computational algorithms, it is prudent to be certain that students understand the *meaning* of the concepts involved and have a sense of *why* the computational procedures work. While it may be easy for students to come to grips with operations on numbers (e.g., picturing 3 + 4 as 3 apples placed next to 4 apples), it is more difficult to envision *relations* between numbers (e.g., 30% of 50).

Students who have just finished a textbook chapter on percents often say, "Do I multiply or divide?" when presented with a task involving percents, probably indicating that they do not have a meaningful sense of what percents are all about. For students to benefit from instruction on how to compute the various types of percent problems, they must also be able to (a) describe the meaning of the term *percent* and the symbols used to represent it (e.g., 30%); (b) understand that percent indicates a comparison between two quantities, a whole amount and a part or multiple of that amount, while using a standard of 100; (c) understand the "how" and "why" of computational procedures and be able to visualize them (e.g., 30% of 50 means you can cut 50 into 100 parts, then put together 30 of those parts); and (d) evaluate the reasonableness of a computational result using mental math (e.g., 30% of 50 should be quite a bit less than half of 50), a visual image (e.g., 100-square grid, see below) or a calculator.

What students are learning should make sense to them. Sense making in mathematics is enhanced through experiences that approach a topic from different perspectives, use different senses and different kinds of thinking, and appeal to different learning styles. Sense-making experiences provide the basis for understanding computational algorithms and demonstrate to the student that there may be many paths to the same end. In addition, sense-making experiences can form the basis for developing meaningful back-up strategies to be used when computational procedures fail due to memory lapse or arithmetic error.

Sense making is not achieved all at once, but rather is a complex process requiring reexperiencing and rethinking, remembering and reconstructing. Two examples of different types of activities that support sense making, including concrete representations and mental math, are outlined below; neither is meant as a one-time activity, but rather they both should be repeated periodically in varied ways to ensure that students understand the meaning of computational procedures.

Activity 3. Visualizing percents.

Part A: Visualizing percents as parts of a whole

Purpose This activity enables students to "see" the idea of percent and introduces the "benchmark" percents of 100%, 50%, 25%, 10%, and 1% to support sense making. The teacher and class members can use these shared experiences as a common "language" to enhance communication during discussions throughout the study of percents. This activity builds on students' informal knowledge explored in Activities 1 and 2.

Materials to prepare

Create a number of "100 square" grids of different dimensions and shapes for each student (see page 19 of this packet for a sample that may be copied). Have available a number of different color crayons or markers.

What to do

1. Ask students to choose one of the 100-square grids on their paper and color/shade 50% of the boxes. (Almost all adult students know that 50% equals half.) Encourage students to describe what they did and why (introducing the term *percent* as indicating parts of 100, highlighting the

idea that 50% is the same as one half because 50 parts represent one half of 100 parts).

2. Ask students to compare with each other the *amounts* of space that they colored and explain why some of them colored different *amounts*, even though each person colored 50%. (Not all grids are the same size; the idea of a *relative* amount [50% as half of 100] rather than an *absolute* amount should emerge.)
3. Discuss what it would mean to color 25%, 10%, and 1% of a grid. Have students color these percentages on the same figure on which they colored 50%. Encourage students to make observations and draw conclusions as to (a) the meaning of a certain percent (i.e., 25% means 25 out of 100 squares), (b) proportional size (i.e., 25% is a quarter of the whole grid, 25% is half of 50% of the grid), and (c) numerical relationships (i.e., four 25s equal 100, 25 is half of 50, 25 is more than twice 10).
4. Using the other 100-square grids, students can color in squares making designs or pictures. Each student should find the percentage of each grid that was colored in each color (such as 27% blue, 12% black, 42% left blank). Have students compare totals for each shape (should total 100% for each shape).

Concepts and connections to emphasize

(See Activity 1 for details.)

Extensions

Using the same 100-square pictures generated above, have groups of students write each percent as a fraction ("25 over 100"), say the fraction aloud ("25 hundredths"), and then write it in decimal form, and finally reduce the fraction. During the entire study of percents, frequently move between percents, fractions, and decimals whenever appropriate to emphasize that these are merely different representations of the same concept.

Part B: Visualizing and finding a percent of a quantity

Purpose

In the previous activity, students explored the meaning of percents with grids and cells, but without real contexts or relationships to other quantities. In this activity, students realize that any real-world quantity can be "mapped" onto a 100-square grid; students visualize the process of "cutting" any given amount or entity into 100 equal parts as a stepping stone to making sense of computing percents. This conceptual step is critical, but is seldom discussed in textbooks.

Materials to prepare

Copy a number of "100 squares" of different dimensions and shapes onto overhead acetate transparencies so that each group of students has one copy of each shape (see page 19 of this packet for a sample that may be copied). Make a equal number of copies of the figures on page 20 or create other drawings or shapes that will fill the outside dimensions of one of the 100-square shapes, while displaying equal portions within each of the squares.

What to do

1. ***Percentages of quantities greater than or equal to 100.***
   (a) Divide the class into groups of two or three, giving each group a set of acetate 100-square grids of different sizes and the paper drawings. Have students overlay acetate 100-squares on the paper representations of 100 dollars and 300 dots, matching the size and shape of the grid to that of the drawing. Students should examine how much of the 100

dollars and 300 dots appear within 100%, 50%, 25%, 10%, 1% of the appropriate 100-square grids, recording their observations in an organized manner such as:

100 DOLLARS:	100% = _____	50% = _____	25% = _____	10% = _____	1% = _____
300 DOTS:	100% = _____	50% = _____	25% = _____	10% = _____	1% = _____

Discuss with students the patterns that they see (e.g., between 100%, 10%, and 1% of each quantity).

(b) Present a number of different amounts divisible by 100 (e.g., 200 beans, 500 cards) and ask students to imagine each of these quantities separated into 100 squares. Discuss students' ideas of the amounts within one square (1%) and the different ways one might find out the other benchmark percent amounts (10%, 25%, 50%) of the original quantity (e.g., what are some of the different ways of finding out what 25% of 200 beans would be?). Ask the class for suggestions on how to divide 150 pieces of gum so that the same amount would be in each of 100 squares, referencing benchmark percents, but not computing them.

2. ***Percentages of quantities less than 100.***

(a) Repeat Step 1 for the other two drawings, 50 people and 25 pizzas. Have the groups report their findings, negotiating variations between observations and recording observations below the results from Step 1. Expect some difficulty particularly with 1% as fractions or decimals will have to be used, but aim for students to "see" 1% of the 25 pizzas as the 25 pizzas divided into 100 parts.

(b) Again, discuss student observations in terms of the relationship between different percentages, numerical patterns (between 100%, 10%, and 1%), relating percents to fractions, differences between percentages of larger and smaller quantities, and so forth. If students have difficulty relating percents to fractions (e.g., 25% is one fourth or one quarter) or identifying fractional parts of quantities (e.g., quarters of pizza), some fraction review discussions may be necessary.

Concepts and connections to emphasize

1. Every quantity can be divided into 100 parts, with each part equal to 1% of the quantity.
2. Encourage students to make connections between fractions and percents, identifying amounts and using terminologies from both representational systems interchangeably.
3. Attention should be paid to the language used in discussing percents. Some students may be confused by the use and meaning of "is" and "of" (e.g., "show me how much is 50% of 10"); they may have trouble mapping such requests into everyday language and understanding how the numbers in the request relate to each other. Whenever possible, embed all discussion in your students' familiar, real-world-based language.

Extensions

1. Use the information generated to see what other percents of the pictured quantities would look like (e.g., 2% is the same as 1% plus 1%, 35% is the same as 25% plus 10%, etc.), checking ideas by overlaying the 100 squares over the pizzas, dollars, dots, and so forth, and then counting quantities.
2. Using the information generated above and the representations, develop the idea of percents greater than 100 (if 100% of 25 pizzas is 25 pizzas and 50% of 25 pizzas is 12 and 1/2, then 150% of 25 pizzas must be . . .).

3. While concrete objects such as beans or kernels of corn could have been used for these percent activities rather than pictorial representations, the actual counting of objects is secondary to the development of notions of the relationships involved. Thus, the availability of multiple examples of different sizes for the students to examine was given precedence over one example with large numbers of small objects.

Activity 4. Mental math with "benchmark numbers."

Purpose

To develop mental math skills. Mental math involves doing calculations "in one's head" in diverse ways that are different than formal (written) algorithms but that ease the mental load and lead to quick (though on occasion approximated) results. People can deal with many real-life percent tasks by using only few benchmark percents (50%, 25%, 10%, 1%) and their fractional equivalents. Developing mental math skills in percents before studying computational algorithms helps students gain an intuitive sense of percent tasks and find meaning in computational procedures.

Materials

Calculators can be used in Step 4. Have 100-square grids available as backup.

What to do

1. ***Pre-activity.*** Discuss real-life situations in which *exact answers* are appropriate (e.g., nurse diluting medication) and contrast with those where *estimates* or *in-the-head* computations are acceptable (computing a 15% tip, deciding if the sale price of an item is appealing). Discuss the advantages of being able to figure out numbers mentally (quick, efficient, no need to find a pencil or calculator). Students will need to become comfortable with the idea of using nonstandard computations as long as they produce the same result as standard ones. (Point out that the use of a calculator also involves a procedure different than the one used for written calculations.) Students need to know common fractions such as one half, one fourth, and one tenth, and understand their interrelations (e.g., one fourth is a half of a half).
2. ***Finding benchmark percents.*** Explore the meaning of the benchmark percents (50%, 25%, 10%, 1%). Discuss fractional equivalents, reference the monetary system and 100-square visual representations (see above activities 1-3). Begin with 50%, then move through 25%, 10% ,and 1%, working with each percent separately. Have the class generate multiple ways to mentally compute each percent. (For 25% of $10, for example, (a) divide $10 by four since 25% is a quarter or one fourth of a given quantity; (b) divide in half and then divide that answer in half; or (c) 25% of one dollar is 25 cents since 1% is "one cent on the dollar," so if there are $10, multiply by 10.)
   Students are often less familiar with 10% and 1% than with 50% and 25%, and may be unaware of the properties of dividing by 10 or 100. Using calculators, have students divide three and four digit numbers by 10 and by 100, keeping track of results. Discuss these observations with the class prior to beginning practice with mentally finding 10% and 1% of quantities.
3. ***Finding more difficult percents.*** Ask students how benchmark percents can help find *any* percent of a given amount *in their heads*. Let students come up with the idea of partitioning a difficult percent into easier units, finding their values, then "recomposing" or adding component values. Encourage students to see the many ways in which they can break-up or

regroup numbers to deal with percents that are not benchmark percents. Discuss finding, say, 35%, 20%, or 7% of round amounts such as $30 (e.g., 35% via 25% + 10%, or via 10% + 10% + 10% + half of 10%; 7% via half of 10% + 1% + 1%). After students feel comfortable with these skills, gradually begin to find percents of nonmonetary and less convenient base amounts, such as 16 ounces, 28 miles, or 260,500,000 people. Embed the base number and the percent in a realistic story (e.g., "A soft drink that usually comes in a 16-ounce bottle is advertising 20% more free; what is the new bottle size?" or, "Every year 3% of the U.S. population contracts disease X; how many people are affected?"). Some stories may call for approximations, not precise answers, requiring students to round difficult numbers and use estimation skills.

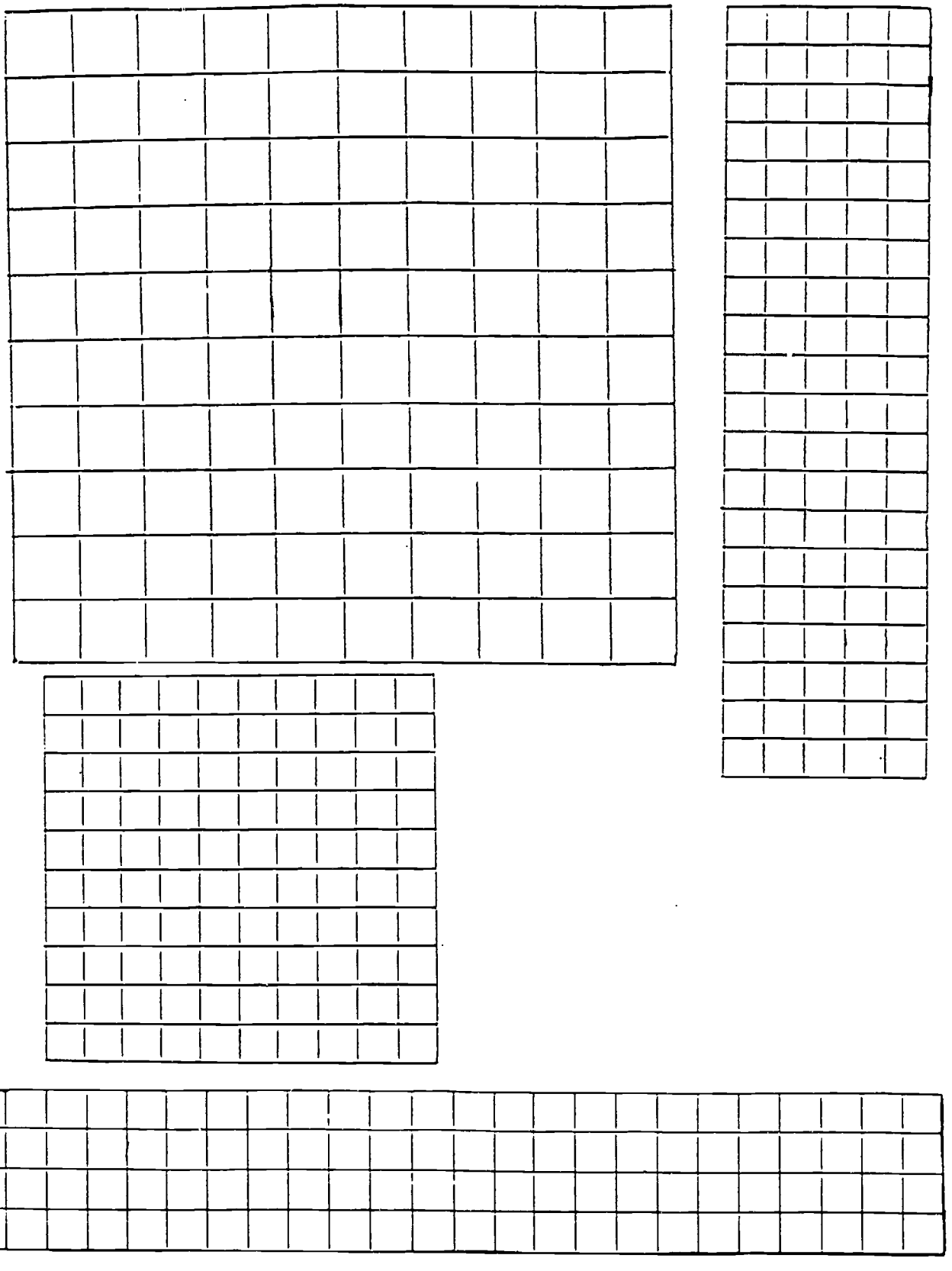
4. ***Checking mental computations with calculators***. Have students generate and solve percent problems with mental math. Use calculators to check accuracy of answers in more than one way, including using the % key and dividing by 2, 4, 10, 100. (Some may want to multiply by decimals instead of using such calculations, following the traditional move-the-decimal-point algorithm, but this should not be stressed.)

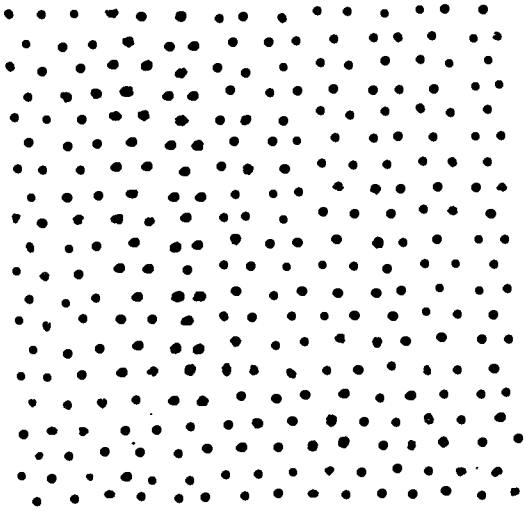
Concepts and connections to emphasize

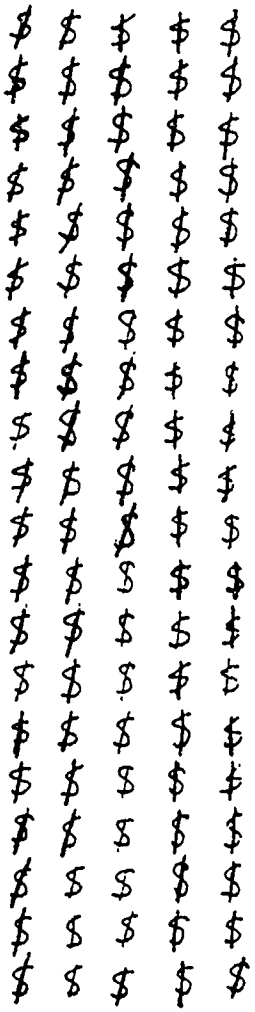
1. Students usually find this type of activity fun and empowering; things "make sense" and are not complicated with rules to memorize. Stress that most people, from mathematicians to laypeople, use mental math when it makes sense, and select strategies depending on the numbers involved, always seeking the easiest way out, including the conversion of percents to fractions or decimals and back, as needed.
2. If students have difficulty moving from 50% and 25% to less familiar benchmark percents, use earlier activities focusing on 100-square grids (see above) to establish a visual imagery for percents.
3. Mental math relies on an understanding of the equivalence among fraction, decimal, and percent representations as well as on an awareness of numerical patterns. Instruction should reinforce skill in moving from one to the other, while allowing students to develop their own preferences.
4. Anticipate that some students will have trouble with the language used, not with the underlying mathematical concepts. Seemingly benign statements such as "divide 50% by a half" or "50 divided into 2" (which for some people may mean the same thing) can have multiple or unstable interpretations and can confuse students. Students may have trouble moving back and forth between everyday and "math class" language, especially when presumably familiar terms that express a relation (is, by, of, into) are used. Thus, it is essential to embed requests in familiar and realistic contexts, using clear language and complete sentences.

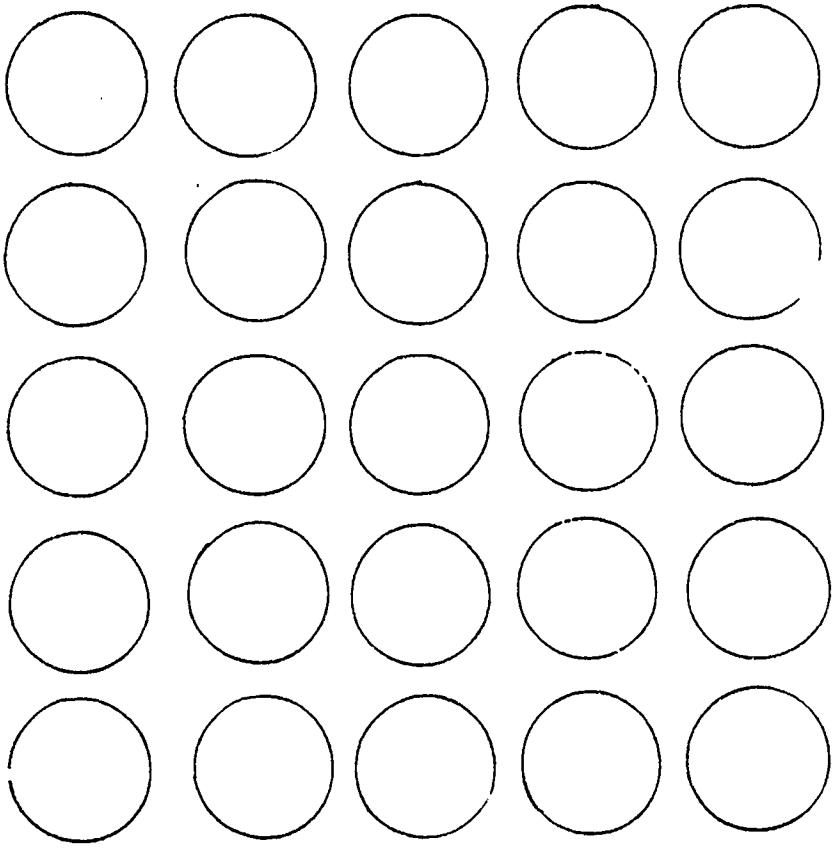
Extensions

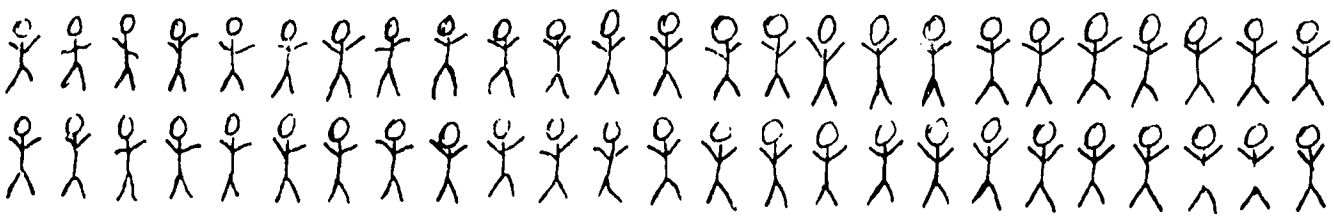
1. Review with students their responses to Activity 2, where they listed percents commonly encountered in their life, and discuss how to approach such percents via mental math.
2. Have students generate new math stories based in their own experiences. Have them present such stories to each other *orally* (not in writing). Students should explain whether they would use mental math, rounding, estimation, written computation, or calculators, and why, when handling percents (or other numbers).
3. If your students have not worked with mental math at other points in the curriculum, you might discuss the uses, helpful benchmarks, and strategies of mental math for other topics.











III. Developing Interpretive Skills and Literacy-Numeracy Connections.

Many everyday and workplace situations require that adults comprehend, act upon, or derive opinions about *numerical information embedded in text* (e.g., reading a rental agreement, placing a catalog order, or reading medical news in a newspaper). Effective handling of such situations requires few if any computational skills. Rather, people are able to combine certain literacy skills with some mathematical *conceptual understanding*, and are able to *communicate* (verbally or in writing) and explain their opinions or actions in such situations.

We need to create classroom environments that simulate how processes of reading, writing, speaking, listening, interpreting, and reasoning *interact* or support each other during functioning in realistic situations involving mathematical elements. Research suggests that such "situated" instruction increases the chance that students later on will be able to use their skills in an integrative way and apply them to new and complex problems.

There are multiple ways to increase the number of literacy-related or communicative events when teaching mathematics. Many teachers are discovering the instructional benefits inherent in having students write math journals or "math histories," develop word problems or "math stories" based on their own experiences, or discuss the pros and cons of different solution strategies.

While such methods are worthwhile, their impact may be limited if the tasks employed do not ask students to adapt their writing for specific audiences, operate within the constraints of real-world environments, or interact with naturally occurring texts. (Describing in one's journal the difficulties encountered when solving a word problem is quite different than, for example, writing a formal letter of complaint about an error in billing or preparing a report about production problems at work.)

This section presents two sample activities that demonstrate how students' literacy and numeracy skills can be simultaneously enhanced through the use of interpretive tasks that make use of authentic text with embedded numerical information. Such activities can save valuable classroom time, because students develop literacy skills while they learn mathematics. As there are many different types of such texts and they may differ greatly in complexity and content, readers are encouraged to adapt the general approach suggested here for use with any other text of relevance and interest to their students.

Activity 5: Percents in graphs-Who Gets Welfare?

Purpose

Students develop interpretive skills as well as extend their percent and graph comprehension skills, but without the burden of computation. Using graphs, tables, or charts from newspapers or magazines allows students to situate learning in a realistic context, and it can help to identify and clarify misunderstandings about percent and other mathematical concepts.

What to do

1. Make copies of the clipping "Who Gets Welfare?" (see page 23) for all students in the class. Allow students time to study the information in the clipping.
2. Begin a classroom discussion with questions that focus on literal reading and comprehension, and gradually move to questions that require interpretation and conjecturing, as illustrated below.

Basic and comprehension questions

These help students learn to read or "lift" information off the graph or chart and comprehend basic statements made in related text (either in the body of the graph or in the newspaper article that the graph accompanies). Examples are

1. What percent of families on welfare consist of more than four people?
2. What do the shadings in the map of the United States represent?
3. In which states is the number of people receiving welfare growing the fastest?
4. Explain the statement that there has been a 25% change in welfare caseloads from 1989 to 1993? What may be the actual numbers involved?

Interpretation and opinion questions

These questions require students to understand the meaning or implications of the information represented in the graph or chart; students may be asked to form an opinion, make a judgment or conjecture, or critique the information in light of their understanding of the mathematical and graphical elements presented, the data given, and their world knowledge.

Note that *none* of the questions below have right or wrong answers, and that they do not indicate what information to use. Questions should be phrased so as to encourage students to explain what *evidence* (displays, data, text) and *reasoning* support their response. The more complex questions can be assigned as group writing projects. Students can exchange drafts and suggest revisions in each other's written reports. (For this part to be effective, a relevant target audience needs to be identified, such as a newspaper editor, a public official, a local employer, or a local newsletter.) Examples for generic questions that can fit many types of texts are

1. What conclusions can you draw from this information? Have you come across any surprising things (good or bad) in the text? What potential problems (or solutions) may be implied by these data?
2. Summarize *succinctly* the information presented (e.g., describe the "typical" welfare recipient as best as you can based on this data; explain how you decided what is "typical," and what information is lost when you summarize data).
3. Some people argue that the welfare system encourages recipients to have more children. How might you use the information presented here to respond to such a claim? (Students should bring in their own world knowledge to bear on this question.)
4. What other information might be needed to form a more informed opinion on this matter? Do you have any concerns about the accuracy and quality of the data?

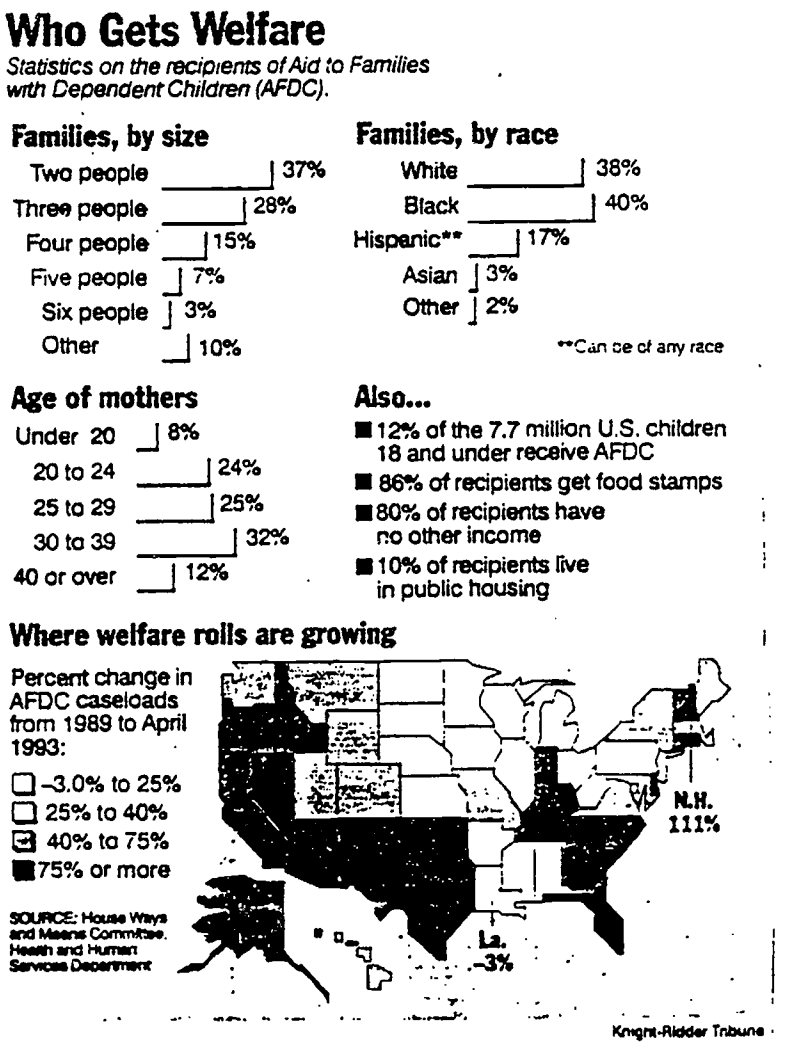
Concepts and connections to emphasize

1. This activity underlines the importance of learning to make sense and be critical (but also appreciative of the power) of numerical and statistical information presented in the media. Various statistical ideas (e.g., sample, data, average, survey, error) and mathematical ideas (e.g., graph, percent, proportion, rate) should be raised and interconnected; the notion of what counts as "sufficient" or "credible" evidence should be examined.
2. While some questions should establish that students can "read" a graph or math-rich text, the emphasis should be increasingly on writing, discussing, and explaining opinions. To support such processes, as in teaching reading, students should develop their ability to simultaneously monitor their understanding of *both* the mathematical and textual information.
3. Students can be helped by first seeing a teacher *modeling* the process of interpretation and critical analysis of text and data; later discussion could

focus on what may be involved in comprehending and interpreting math-rich text (e.g., how certain terms have both mathematical and everyday meanings), before starting to work through the various questions above.

Extensions

Interpretive tasks are very relevant for adult students, and they can lead to a deeper understanding of the connections between mathematical ideas and concepts, as well as their connections to other disciplines (e.g., science, social studies). You can find many other useful texts for classroom use in local or national newspapers (e.g., *USA Today*); or have students bring in clippings from newsletters, magazines, or brochures and develop their own learning tasks from tasks.



Who Gets Welfare

Statistics on the recipients of Aid to Families with Dependent Children (AFDC).

Families, by size

Two people	37%
Three people	28%
Four people	15%
Five people	7%
Six people	3%
Other	10%

Families, by race

White	38%
Black	40%
Hispanic**	17%
Asian	3%
Other	2%

**Can be of any race

Age of mothers

Under 20	8%
20 to 24	24%
25 to 29	25%
30 to 39	32%
40 or over	12%

Also...

- 12% of the 7.7 million U.S. children 18 and under receive AFDC
- 86% of recipients get food stamps
- 80% of recipients have no other income
- 10% of recipients live in public housing

Where welfare rolls are growing

Percent change in AFDC caseloads from 1989 to April 1993:

- –3.0% to 25%
- 25% to 40%
- 40% to 75%
- 75% or more

SOURCE: House Ways and Means Committee, Health and Human Services Department

Knight-Ridder Tribune

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Activity 6. Making sense of quantitative claims in the media.

Purpose To extend the instructional ideas presented in Activity 5, by asking students to interpret and react to articles or other texts in newspapers and magazines that may not be accompanied by graphical displays. Such articles often address advanced uses of percent that seldom come up in textbooks, despite their role in establishing students' *conceptual understanding* (uses such as percents that indicate increase or decrease, rate change across time periods, percent of percent, or percents larger than 100% or smaller than 1%). Also, the discussion of such percents is often embedded in scientific and societal issues, allowing progress towards broader educational goals.

Materials Copy the article "Baseball price list hits higher average" for all students. (Substitute other provocative texts that mention percents, averages, or statistical trends, e.g., on results of surveys, medical issues, changes in crime or unemployment rates, educational gains. Notice that even though some articles may have few or no numbers, they can still serve as a great context to discuss quantitative issues. Consider using chapters from science or social studies texts such as those used for GED preparation, which have many statistical claims.)

What to do Allow students to read the text silently and to ask questions about any unfamiliar vocabulary. See suggestions in Activity 5 on how to move from comprehension to interpretation tasks. In addition to the generic questions suggested in Activity 5, here are additional examples:

Comprehension questions

1. What does it mean that average prices rose about 9%? Does this mean that all stadiums raised their prices by 9%?
2. Explain how the FCI (Fan Cost Index) is calculated.
3. Why are percents used throughout the article? *Note: this is a critical question. Students should discuss why percents (and averages), rather than absolute numbers, are usually reported in the media.*

Interpretation and opinion questions

1. What factors appear to influence baseball ticket prices?
2. What may be the impact of trends discussed in the article on future attendance in baseball games?
3. What predictions can you make regarding the average ticket cost next year? What evidence is used to support this prediction?
4. If the person who wrote this article was here, what would you ask him or her in order to clarify the information presented in the article or to learn more about this topic?

Extensions

1. Use the information in the article to create computation questions for student practice. For example, if the average ticket price this year is $10.45, approximately what was the average price last year? (Suggest the use of calculators.)
2. Use a newspaper article such as this one to *assess* students' understanding of percents.
3. Whichever text you choose, make up a reasonable scenario within which to require students to prepare a presentation or brief report. Specify who is

the audience and how much time or space is available for the response in order to simulate realistic constraints.

4. If you choose a rich text that addresses a complex issue, consider arranging a debate or a role play where different students present opposing views on an issue.

Baseball price list hits higher average

If economists are sniffing for telltale signs of inflation, here's a hint: Major League Baseball ticket prices.

This season, average prices rose about 9% — after just a 2% hike last year. For the first time, the average ticket costs more than $10 ($10.45).

A survey by *Team Marketing Report*, a Chicago newsletter, found new evidence of continuing trends:

▶ Once again, owners see the debut of a stadium as a good time to raise prices. The Texas Rangers, in new digs, raised ticket prices 35%. Cleveland's new seats are up 39% from '93.

▶ Expensive seats keep getting more expensive. *TMR* says 30% of all MLB tickets are now priced above $12 — up from 20% at that level last season.

▶ Cheap seats are scarcer. This season, 28% are less than $8 — compared to 33% last year.

Fans' consolation prize: Concession prices rose just 3% — after 7% and 13% hikes the last two years.

TMR also has a Fan Cost Index, which includes the cost of four average-priced tickets, concessions, parking and souvenirs for four people at a game. Baseball's overall FCI has risen 26% since 1991 — to $95.80 now.

And if the New York Yankees haven't caught the Toronto Blue Jays on the field, they at least have taken over the No. 1 spot in prices. The Yanks passed the Jays in average ticket prices ($14.44) and the cost of taking a family to the ballpark ($115.25).

— *Michael Hiestand*

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IV. Integrative Tasks.

In many real-life contexts, decisions or actions must be made based on some numerical information interspersed with other information. Examples include personal finance decisions, planning events, or evaluating alternative insurance, rental, transportation, or scheduling options. There is often little direction as to how to proceed; there is a range of "reasonable" approaches and solutions whose degree of acceptability depends on the demands of the situation and on the skills and preferences of the problem solver. (Think of the last time you planned a party, dinner, or trip.)

The following activities aim to encourage a shift from learning specific mathematical skills one at a time (which is entrenched by the widespread use of single-skill worksheets) to performing more complex tasks. These tasks require people to collect appropriate information and to use selectively and *in integration* multiple kinds of knowledge and skills, including mathematical tools and mathematical reasoning, general problem-solving skills, literacy skills, and other relevant knowledge. These performance tasks (a) usually take from 30 to 90 minutes; (b) do not have one right or wrong answer, but rather shades of quality; (c) require the creative use and integration of multiple tools in order to formulate original responses (the desired outcome is known, but the methods or processes to achieve it are not specified); and (d) require the student to create a product that may be a presentation, report, model, poster, or letter outlining the student's decision and explaining or justifying the basis of that decision.

Activity 7. What should I choose?

Purpose

This activity models a familiar, real-life situation that requires individuals to compare a number of options, each carrying with it multiple attributes, some of which are numerical and some of which are not, in order to choose a course of action. Students must identify pertinent information within documents, evaluate and weigh the importance and relevance of known information, and finally, make and be able to justify a decision that takes into account multiple variables and personal considerations.

Materials to Prepare

Find three credit card advertisements that have different combinations of annual fees, interest rates, and other criteria (such as "grace periods"). Make copies of each of three advertisements for each student. Provide calculators.

If credit cards are not of much interest to your students, look into any other comparative task that results in a choice or recommendation, such as one involving medical coverage, purchasing a home appliance, choosing a day-care, and so forth. Some of these may involve few variables and will be easier to use as a starting task.

What to do

1. Introduce the topic. Allow students time to study the information presented on one specific credit card advertisement. Briefly discuss the uses and abuses of credit cards. By asking comprehension and interpretation questions, help the students find specific information that can be used to distinguish credit cards, making certain that all students understand the meaning of key terminology. List all the pertinent information on the board.
2. Ask students to compile similar pertinent information from the other two credit card advertisements and to organize all data. (They may search for a while before deciding on a useful table format.)
3. Have students discuss differences between the products being compared (i.e., the cards) and the implications. Examine the details of how the minimum payment is computed; using calculators, compute a number of

examples of minimum payments for each of the credit cards. To ascertain whether students understand the meaning of "interest," also compute the interest on various amounts students might spend (e.g., for holiday gifts), using the different rates given.

4. Direct the discussion to "Are all products [credit cards] the same?" and "Would the same product [credit card] be best for everyone, given differences between people on frequency of use, use of cash advances, paying all charges completely, or carrying a balance?"
5. Each student will decide which of the three credit cards would probably be best for him/herself based on current data and will present (orally or by writing a paragraph) the reasons *why* he or she decided on a particular credit card, citing the factors that were considered. Alternatively, students could write a "letter to a friend" with their recommendation.

Concepts and Connections to Emphasize

1. There are often no absolute right or wrong answers to real-world problems, but alternative decisions carrying different consequences, which can be evaluated. The likelihood that a decision will prove effective in the long run is increased when people consider all the related factors, identifying and emphasizing those that are particularly important for a given situation, yet still keeping in mind other factors, including subjective preferences.
2. In the course of working on "comparative shopping" tasks such as this one, students often *invent* mathematical procedures (e.g., weighing different factors) or otherwise modify formal mathematical algorithms. Such tasks can reengage students who have decided that they are "not good at math" because they can use informal mathematical ideas (parts of whole) in context and begin to see the value of formal mathematical tools (percent).
3. Some tasks require students to consider not only "absolute knowledge" (e.g., interest rates), but also their understanding of and beliefs about probability, personal values, and risk-taking preferences. Depending on the cultural and communal context of your program, consider pointing out the role of such "subjective" factors in larger personal and societal decisions, such as those involving work-related choices, health issues with potential side effects (e.g., immunization, use of contraceptives), pollution control, or other topics that may be the focus of other parts of a literacy program. The use of percents to convey degree of probability and risks, as well as in weighting factors, should be discussed and clarified.

Extensions

1. Students can practice filling out relevant forms (e.g., credit card applications) and providing or computing all requested information.
2. Students can write sample letters asking for information about a product (e.g., as part of a market research), asking to change conditions of an agreement (e.g., extend a lease), or complaining of a problem (e.g., complaining of unauthorized charges to their account).
3. Other real-world situations (such as alternative layaway plans, choice of summer camp, planning a party) can be used, varying the number of choices and the number of factors to be considered. The first integrative tasks used in a class should perhaps only consist of two alternatives with information given about three variables (e.g., a student must decide between two rental apartments that vary over rental costs, proximity to work or current residence, and length of lease).

Activity 8. Detectives at work: "Can we accept this statement?"

Purpose

This activity gives students an opportunity to examine critically a statement presented to them and collect data to refute or support the claim. As students understand that claims should be based on a body of relevant data or on credible evidence, they will be more equipped to ask critical questions about other statements presented in the media or in advertising.

Materials to Prepare

Provide tape measures or rulers (in inches and/or centimeters). Calculators are helpful.

What to do

1. Present the following statement:
   Detective Smarty claims: "From a footprint I find at a crime scene, I can tell a perpetrator's height. My experience tells me that the length of one's foot is 15% of one's height."
2. Elicit students' opinions on the acceptability of this claim and what evidence may be needed to support or refute it. (Students will probably decide to measure some feet and heights to see if the relationship is evident.)
3. The class (or separate groups) should form a data collection plan, discussing and coming to a consensus on issues such as how many people (subjects) should be included in the study, who will be the subjects (e.g., age, gender, background), what to measure and exactly how, and so forth.
4. Students should discuss how data will be recorded and analyzed (tables, charts, computations necessary).
5. Divide the class into groups of three or four to carry out the activity, with help from the teacher or other groups as needed. Once data has been collected, recorded, and examined, groups should prepare a report or presentation to discuss the acceptability of Detective Smarty's statement or what statement the group would find acceptable, justifying their opinions based on their evidence.

Concepts and Connections to Emphasize

1. Discuss the value as well as the pitfalls of using a sample in place of a survey of the entire population, and how logistical considerations inform the use of samples. (Students will be familiar with the idea of a sample from shopping contexts, and would know that a sample is "a little piece that tells you about the whole thing.")
2. Pay attention to fruitful ideas but also to misconceptions that will come up. Many critical statistical ideas can be discussed and promoted, such as (a) the value of small versus large samples; (b) the goal of being able to *infer* from sample-based results to the whole population, and the need for a sample to *represent* a population in essential characteristics to enable this *generalization*; and (c) the difference between a haphazard or "convenience" method of sampling (i.e., whoever is available) and one that is systematic and/or based on random selection.
3. The important notion of variability should come up. Students should recognize that people (or machines, pants, tomatoes) vary, and that the amount of expected variation (or homogeneity) dictates the size of the sample needed to produce a reliable estimate.
4. This task highlights the need to use summarizing statements (such as "15%" or "the average is") to represent a distribution of values. Discuss the spread of the data around the reported value and whether a single summary statement tells the whole story of the data. Discuss the use of

confidence intervals or "margin of error" figures to convey information about the spread.

5. Discuss errors in measurement and how they affect accuracy of data and validity of conclusions. (Did all groups measure the same thing in the same way? Did all members of a group come up with the same measure?)

Extensions

1. Bring other claims from newspapers or advertisements to class and discuss the likely basis for the claims and potential problems (e.g., How large was the sample? Who were the subjects? Who were the researchers, and could they be biased? Were proper variables controlled for in the design of the experiment?).
2. After discussing an issue of relevance to the students in the class, have students design and conduct another survey to gather relevant information and present the results to an appropriate party such as the program director, a local agency, or a local employer.
3. Activities that involve collection of data and statistical work are an important component in preparing students for work in companies that use Statistical Process Control or rely on data collection to improve quality of production and service. Link with a local employer to bring into the classroom the workplace applications of statistical knowledge.

Adult Numeracy Instruction: A New Approach

Part B: Numeracy Resources and Initiatives

Section 4. NCTM and Its Efforts to Reform Mathematics Education.

The National Council of Teachers of Mathematics (NCTM) is a professional association whose membership of about 100,000 traditionally has been teachers of mathematics in elementary and secondary schools and in colleges. However, NCTM is increasingly trying to serve educators who teach mathematics in diverse contexts as part of its efforts to reform mathematics education.

The flagship products of the NCTM reform initiative are three publications that frame its recommendations and speak to the needs of both traditional and nontraditional learners. The first, *Curriculum and Evaluation Standards for School Mathematics* (1989), outlines in broad strokes the mathematical skills and knowledge that are important for students to master at different stages of their education. The second, *Professional Standards for Teaching Mathematics* (1991), provides recommendations for the types of classroom environments and instruction that are necessary so that students achieve the knowledge and skills outlined in the *Curriculum Standards*. The third, *Assessment Standards for School Mathematics* (now in final draft form), describes the rich and diverse ways in which students' knowledge and problem-solving processes should be evaluated so as to support their learning and inform teachers' instructional plans and practices.

The various standards are not rigid specifications but rather present broad visions for teachers to consider. The publications also give illustrative examples of the various ways in which these visions can be implemented in different types of classroom contexts and at all levels of instruction. At this point in time, many K-12 mathematics teachers (and some adult educators) are actively examining the various NCTM standards. Many teachers appear to have found ways to adapt their instruction in light of some or all of the NCTM recommendations, and they report encouraging results.

Although an educational reform process may take years to create critical changes, it is important to note that the publication of the NCTM standards has already had a visible impact on the content of instructional materials and on staff development initiatives in K-12 contexts. The existence of the standards appears to have provided a common "language" for communication among publishers, curriculum developers, trainers, and teachers in a way that facilitates instructional and training decisions.

The ABE Math Standards Project. The NCTM standards formed the basis for the Massachusetts Adult Basic Education Math Standards Project, which started in 1992. A group of 22 adult educators in Massachusetts worked for two years to examine and adapt the NCTM standards for use with adult students learning in GED, ESL, ABE, and workplace contexts. After a study period, each of these adult educators implemented one or more of the recommended curriculum or teaching standards in her or his classroom and researched the results. Based on these experiences, the team wrote a concise proposal for goals of mathematics education for adults, for consideration by adult educators around the country (see resource listing for more information).

Some key ideas outlined in the NCTM and Massachusetts documents are outlined below to enrich the dialogue about the curricular goals, methods, and practices that should be adopted by those involved in adult numeracy education. It is this dialogue that the videoconference and this packet aim to inform.

Key Contributions of the NCTM Standards

The NCTM *Curriculum Standards* outlines the key skills and knowledge that students should develop as part of their mathematics education. Yet, there is separate emphasis on specific content skills and on the more important "overarching" process skills, which should permeate all instruction.

The *Curriculum Standards* discusses what is important to teach in key domains in three grade levels (K-4, 5-8, 9-12). Although there are some differences in the domains emphasized for each grade level, key domains that may be of interest to adult educators (especially when couched in adult-oriented language and life contexts such as are used in the Massachusetts ABE Math Standards report) include number operations and relations, and number sense; estimation and computation; measurement; geometry and spatial sense; algebra; functions and patterns; statistics; and probability. The *Curriculum Standards* makes it clear that, while the computational, formula-oriented skills, which comprise much of the traditional mathematics curriculum, are not unimportant, they are only a small subset of what individuals must learn to become mathematically literate.

A key contribution of the new standards is their emphasis on four overarching processes (problem solving, reasoning, communication, and connections). These processes should underlie instruction in any specific content area in mathematics and should be integrated with the instructional experiences

offered to all students at all levels and contexts of instruction. Below are brief discussions of the ideas behind these process standards.

Mathematics as Problem Solving

Instruction should be conducted in such a way that students become able to use, with increasing confidence, problem-solving approaches to investigate and understand mathematical content. Further, students should be able to apply mathematical problem-solving strategies and modeling to problems from within and outside mathematics classrooms. Being able to solve complex, real-world problems is clearly important for all learners. Development of problem-solving skills should involve much more than coping with computational tasks or word problems commonly found in math textbooks, which almost always have one right solution. Instead, problem-solving skills should also be developed in the context of richer and worthwhile tasks (in contrast to contrived tasks that do not replicate real-world problem situations). Such tasks should allow for multiple-solution strategies, encourage the use of different tools or representations, and require students to generate diverse "products" and responses.

Mathematics as Reasoning

Students need to be able to try different ways of solving a given problem, and find what mathematics is most helpful for reaching a reasonable solution. In this process, students should be able to make and test conjectures, formulate counter-examples, and construct and follow logical arguments. Since communicating or arguing about the reasoning behind choices and solutions is commonly encountered by adults in the workplace and in activities in many social contexts, it should also be expected in the classroom. Tasks and problems used by teachers or projects chosen by students, should increasingly enable richer and more elaborate reasoning, encouraged by asking students to describe and argue for their logic or opinions (verbally or in writing) and by creating opportunities for students to participate in group problem solving.

Mathematics as Communication

Students at all levels are increasingly expected to be able to explain their answers, articulate their thinking, and describe their problem-solving or reasoning processes, both verbally and in writing. Similarly, students are expected to understand and be able to respond to the solutions or arguments expressed by others. To develop students' communicative skills in the context of learning mathematics, tasks presented to students must not dictate a single solution process or lead to a single right answer.

Mathematical Connections

Students must see connections within and outside mathematics. First, they should see the links between the various mathematical ideas, concepts, and skills that they develop when studying different areas of mathematics (e.g., number operations, measurement, and statistics). Students should also see the connections between what they study in mathematics and what they study in other domains (e.g., science, social studies), or what is required of them outside school. Discussions about mathematical connections are critical for increasing learners' motivation to study mathematics.

Readers are encouraged to go beyond the brief comments provided in this section and obtain more complete information about the NCTM and Massachusetts ABE Math Standards publications, in order to fully evaluate their relevance for adult numeracy education; also, see discussions of the SCANS recommendations which follow for perspectives that extend beyond the math standards discussed here. Section 3 presents sample activities that demonstrate how the four broad "process standards," as well as instructional principles listed earlier in Section 1, can be implemented in the classroom. See the "Selected Math and Numeracy Resources" section for more information.

Section 5. SCANS Summary – Math in the Workplace.

Since 1991, the U.S. Department of Labor has issued several reports of the Secretary's Commission on Achieving the Necessary Skills (SCANS). These documents examine the demands of high-performance workplaces and the needed levels of proficiency in different skills areas, and they highlight the implications of workplace requirements for educators, schools, and teaching practices. The SCANS commission has conducted extensive interviews with employers, trainers, and workers from various industries. The commission also studied the perspectives of schools and educators before issuing its recommendations.

The Five Workplace Competencies

To prepare workers for the workplace, the SCANS reports focus on "generic" duties or tasks (called "competencies") that workers will have to actually perform in most jobs, rather than on technical preparation for specific occupations. It places these competencies in the following categories.

Resources. Time (allocate time, and prepare and follow schedules), money (prepare budgets, make forecasts, keep records, monitor expenses), materials and facilities (acquire, store, allocate, and use materials, supplies, or space efficiently), and human resources (distribute work and schedule activities according to known tasks and assessment of people's skills).

Interpersonal. Contribute to group effort as a member of a team; teach others new skills; work to satisfy customers' expectations; communicate ideas to justify position or to persuade, responsibly challenge existing procedures and policies; negotiate exchange of resources, resolve divergent interests; and work well with men and women from diverse backgrounds.

Information. Acquire, use, organize, and maintain information; interpret and communicate information; use computers to process information.

Systems. Understand how social, organizational, and technological systems work, and operate effectively within them. Monitor performance, correct problems, and predict impacts on system operations. Suggest modifications to improve system performance.

Technology. Work with a variety of technologies. Choose procedures, tools, or equipment, including computers, and apply to tasks. Understand overall intent and proper procedures for setup, operation, maintenance, and troubleshooting of equipment, computers, and other technologies.

Note: Most of the above areas of performance involve either handling of numerical information or understanding of some mathematical relationships. "Resources" is an obvious example; workers, those in entry-level or low-wage positions and up need to be able to deal with schedules, monitor use of supplies, estimate flow of work, and deal effectively with money, including their personal finances and expenses. However, many of these workplace competencies do not fit neatly under traditional subject areas in mathematics (e.g., where does "reading information about employee benefits and choosing optimal health care coverage" fit?). There are many skills besides mathematical skills that affect work performance, and their development should be integrated within numeracy education, so that multiple goals are achieved simultaneously.

A Three-Part Foundation Enabling Workplace Competencies to Develop

The SCANS Commission states that students leaving a school or education program should be able to demonstrate certain foundation skills at the following level:

Basic Skills. Read and write well enough to handle records, memoranda, and correspondence without difficulty; locate, understand, and interpret written information; and communicate ideas clearly and concisely in writing, using prose and visual displays (e.g., charts) as required.

Understand mathematics well enough to make simple computations, estimate results, interpret and develop diagrams and charts, approach practical problems by choosing appropriately from a variety of mathematical techniques, work with computer programs, apply mathematics in real-world situations, and understand the role of chance in the occurrence of events.

Speak clearly and persuasively as the job requires--respond to complaints, make group presentations, and ask questions when instructions are unclear or if competing job requirements are ambiguous.

Listen carefully to understand messages, to benefit from time spent in training, and to pick up the motivations and hidden messages of customers, clients, coworkers, or supervisors.

Thinking Skills. Think creatively, make decisions (specify goals and constraints, generate alternatives, consider risks, and evaluate and choose best alternative). Recognize problems and devise and implement plans of action. Organize and process symbols, pictures, graphs, objects, and other information in the "mind's eye." Know how to learn. Reason by discovering rules or principles underlying the relationship between objects and apply these rules when solving a problem.

Personal Qualities. Display responsibility and perseverance; maintain self esteem; display sociability, adaptability, and politeness in group settings. Assess self accurately, set personal goals, monitor progress, and exhibit self-control. Demonstrate integrity and choose ethical courses of action.

Educational Implications

The SCANS commission believes, after examining the findings of cognitive science, that the most effective way to teach skills is in context and suggests the following three principles to guide real contextual learning in all schools and programs:

- 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.
- Learning should be reinforced away from mere mastery of information and toward encouraging students to recognize and solve problems.
- Foundation skills and workplace know-how cannot be taught in isolation; students need practice in the application of these skills.

If we expect learners to develop integrative skills or to function in systems (comprised of people, equipment, timelines, regulations, administrative functions, goals, etc.), we should create in the classroom the situations or simulations that require integration of skills, rather than application of isolated, single skills (as when students practice on a worksheet). This is necessary to enable learners to develop the transferable, generic skills that they will be able to apply in most jobs, regardless of their particular content. Thus, individual classroom work needs to be supplemented by increasingly more complex projects involving extended group efforts and aiming at realistic products (e.g., reports, presentations, decisions) that are more complex than brief right-or-wrong answers.

The foundation skills should be assessed along with the workplace competencies that they support. If the students can demonstrate the competency properly, they can be assumed to have the foundation they need. (Notice that the opposite is not true. Students may develop specific mathematical skills, but they may have trouble applying them to new problems.) Choosing between teaching the foundation (e.g., back to basics) and the competencies is false; students usually become more proficient faster if they learn these areas simultaneously and if learning in order *to know* is not separated from learning in order *to do.* Knowledge and its uses belong together.

For adult numeracy educators this means that mathematics should not be taught in a vacuum. By skimming through the SCANS reports (see Section 5 for details), teachers can quickly obtain multiple examples illustrating the diverse ways in which mathematical knowledge is put to use at work or how mathematical skills and know-how interact with other skills in functional environments. These examples and the additional details of needed workplace competencies and foundation skills can inform curricular planning and improve the response to the diverse learning needs of adult students.

Section 6. Summary of the Mathematical Literacy Conference.

This section provides a brief overview of the Working Conference on Adult Mathematical Literacy, which took place on March 20-22, 1994, in Arlington, Virginia. Through a combination of presentations, reading materials, and discussions in small working groups, conference participants examined various questions and pointed to possible next steps that should be considered by individual adult educators as well as by program directors and other decision makers who are interested in improving adult numeracy education.

Please check the "Suggested Math and Numeracy Resources" section of this packet for information on how to obtain the conference proceedings. Note that the proceedings include a highly readable 20-page synthesis of conference discussions and suggestions, as well as 11 brief background chapters (6-8 pages each) on various aspects of adult numeracy education. The list of questions examined by conference participants, the conference summary, and the background chapters can serve as an excellent starting point for individual practitioners as well as for programs/agencies that seek to examine possible reforms in numeracy/math education or to establish a task force in this regard.

Goals

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

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

Participants

Of the 110 invited participants, about half were adult educators directly involved in numeracy-related instruction, teacher training, and curriculum development in GED, ABE, ESL, and workplace literacy programs, and they were selected through an application process to represent over 30 states. The remaining participants included representatives from the mathematics education and adult education communities nationwide, and from federal agencies, nongovernmental organizations, business, educational media, academia, and 14 endorsing organizations.

Key Questions

These questions were examined either by all participants or by specific working groups.

1. What numeracy skills do adults need, and are there gaps between needed and existing numeracy skills of students in adult literacy programs?
2. How ready are the adult education system and the teachers who work in literacy programs to deliver quality instruction that can respond to existing skill gaps in math/numeracy?
3. What implications may recent reform efforts in mathematics education (e.g., at the K-12 level) have for adult numeracy education?
4. What new instructional materials and resources would be needed to support the improvement of adult mathematical literacy? Can materials be borrowed from K-12?

5. What changes might be needed in policy, legislation, interagency coordination, funding, or dissemination methods in order to improve adult mathematical literacy?
6. What changes in instructional practices and in staff development processes would be needed in order to improve adult mathematical literacy skills?

Areas for Change

The conference summary provides a concise synthesis of suggestions made in the eight areas listed below. Space limitations do not allow for a summary of suggestions on each topic. However, some of the suggestions for future next steps that resulted from the conference, such as recommendations for professional development and for changes in instruction in adult math education, are addressed or have informed activities demonstrated during this videoconference, or are reflected in other parts of this conference packet. Specific areas for change include the following:

1. Creating a practitioner network. (See below for details about the Adult Numeracy Practitioner Network established at the conference.)
2. Rethinking curricular goals and program standards.
3. Changing instructional practices and teaching resources.
4. Increasing adult learners' involvement.
5. Improving staff/professional development.
6. Changing assessment frameworks.
7. Providing research support.
8. Examining broader aspects of the current system that affect numeracy education: (a) funding and support, (b) program accountability measures, and (c) communication and dissemination.

What's Next?

The Mathematical Literacy Conference, while exciting in and of itself, is not likely to have long-lasting impact on the field of adult numeracy education unless it becomes a first step in a reform process. Clearly, the complexity of topics involved in improving adult numeracy provision defies quick solutions. However, the challenges that were identified and recommendations that were outlined at the conference can inform a continuing dialogue among members of the adult education and mathematics education communities about the future of adult numeracy education. The proceedings of the conference should help readers plan further actions that will contribute to improving numeracy skills of adults in the United States.

Section 7. The Adult Numeracy Practitioner Network.

The creation of a national organization of adult educators involved in math/numeracy instruction was seen as essential by many of the participants in the Working Conference on Adult Mathematical Literacy, which took place on March 20-22, 1994, in Arlington, Virginia (see above). The need for this organization stems from the fact that K-12 math organizations do not presently attend to adult math education in noncollege contexts, and literacy organizations usually pay little or no attention to mathematical issues.

Mission

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

Prototype Structure

The network started its operation as an independent organization; it may become affiliated with a national organization in the future. An interim steering committee was selected, comprised of a coordinator (Mary Jane Schmitt, MA) and eight regional representatives who will be responsible for disseminating and collecting information from programs and states in their region. Ellen McDevitt (PA) volunteered to serve as editor of the network's newsletter.

Goals and Areas of Activity for the Network

Goal 1: To create awareness of the need for math literacy.

The Numeracy Network and all its members should work to raise awareness, promote math literacy, increase political support via media coverage (e.g., articles in newsletters) and advocacy activities, and promote math workshops at adult education conferences at all levels.

Goal 2: To participate in and improve staff development.

The network must encourage adult educators to utilize already existing structures for staff development in adult education, such as State Literacy Resource Centers or local in-service training. The network should also help adult educators link with staff development opportunities available to K-12 teachers through, for example, the National Council of Teachers of Mathematics, state-affiliated math teacher associations, NSF-funded training, and local school district in-service offerings.

Goal 3: To identify funding sources.

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

Goal 4: To participate in research.

Research initiatives should include teachers as active participants. Research projects should inform effective programming, teaching, and assessments at both the local and national levels.

Present Activities of the Network

At this point in time (September 1994), the Adult Numeracy Practitioner Network has published its first newsletter, titled *The Math Practitioner*, and is planning a second one in October 1994. The network is investigating an electronic bulletin board, facilitating regular communication among the regional representatives, and planning a preconference meeting on April 5, 1995, before the NCTM annual meeting in Boston, April 6-9, 1995. Plans are underway to establish a more formal structure at this meeting. If you are interested in participating in the Adult Numeracy Practitioner Network or obtaining more information about the April 1995 meeting, please see contact information under *Adult Numeracy Practitioner Network* in the section on "Suggested Math and Numeracy Resources."

How to Contact the Adult Numeracy Practitioner Network

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

Coordinator: Mary Jane Schmitt
Department of Education
350 Main Street
Malden, MA 02148-5023
Tel: (617) 388-3300 Ext 364
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The Adult Numeracy Practitioner Network is receiving logistical support from the Numeracy Project, National Center on Adult Literacy.

Section 8. Selected Math and Numeracy Resources.

This bibliography provides a sampling of resources that can be used for professional development. With few exceptions, textbooks and specific classroom materials are not listed here, since there are many publishers who issue dozens of books that are readily available.

General Frameworks

National Council of Teachers of Mathematics. (1989). *Curriculum and evaluation standards for school mathematics.* Reston, VA: Author.
National Council of Teachers of Mathematics. (1991). *Professional standards for teaching mathematics*. Reston, VA: Author. (Approx. 200 pages each)
[Contact: NCTM, P. O. Box 25405, Richmond, VA 23260-5405, phone 800-235-7566. For other inquiries: NCTM, 1906 Association Drive, Reston, VA 22091-1593, phone: 703-620-9840.]

Gal, I., & Schmitt, M. J. (Eds.). (1994). *Proceedings of the conference on adult mathematical literacy.* Philadelphia: University of Pennsylvania, National Center on Adult Literacy.
[Contact: NCAL Dissemination, 3910 Chestnut Street, Philadelphia, PA 19104-3111, phone: 215-898-2100; fax: 215-898-9804.]

The Proceedings include (a) a 20-page conference summary that provides a useful introduction to the current issues and challenges of adult numeracy education, and suggestions for reform and questions for reflection by practitioners and study groups; and (b) 11 brief (6-8 pages) and accessible chapters that introduce various issues and dilemmas involved in reforming adult numeracy education at both the national and local levels.

Leonelli, E., Merson, M. W., Schmitt, M. J., & Schwendeman, R. (Eds.). (1994). *The Massachusetts ABE math standards project.* Holyoke, MA: Holyoke Community College. (2 Vols.)
[Contact: SABES Clearinghouse, World Education, 210 Lincoln St., Boston, MA 02110.]

This is the report of the two-year teacher inquiry project of the Massachusetts ABE Math Team, a group of 22 reform-minded adult basic education teachers. Volume I, *The Massachusetts Adult Basic Education Math Standards*, puts forth a vision of quality math instruction by extending the NCTM Standards to the GED, ABE, ESL, and workplace settings (61 pages). Volume II, *The Massachusetts Adult Basic Education Math Standards: Our Research Stories*, is a compilation of the teachers' research papers, each one telling the story of a journey within his/her classroom as he/she attempted to implement the vision. Rich with authentic examples of how to begin reform (250 pages).

Specific Suggestions for Practice

Note: These are not textbooks, but rather organized collections of illustrative activities or classroom projects that are embedded in general frameworks discussed in the above resources. These resources suggest a range of ways in which new ideas about reforming or extending math/numeracy education could be implemented in practice.

National Council of Teachers of Mathematics. (1992-1994). *The addenda series*. Reston, VA: Multiple authors. (Multiple booklets, 60-90 pages each)
[Contact: NCTM, P. O. Box 25405, Richmond, VA 23260-5405, phone 800-235-7566.]

Following the release of the *NCTM Standards* (1989), field-based teams developed concrete ideas for implementing the standards in classrooms. Each booklet focuses on a specific content area (e.g., measurement, statistics, algebra) for specific K-12 grade levels (K-4, 4-8, 9-12) with the overarching themes of problem solving, connecting, communicating, and reasoning woven throughout. Many adult educators may want to look first at the booklets for grades 5-8, which address many of the skills commonly taught in ABE and pre-GED classes.

Stenmark, J. K., Thompson, V., & Cossey, R. (1986). *Family math.* Berkeley: University of California, Lawrence Hall of Science. (320 pages)
[Contact: Family Math, Lawrence Hall of Science, University of California-Berkeley, Berkeley, CA 94720. Phone: 510-642-1823, or order through a bookstore]

This excellent resource book has dozens of detailed suggestions for math games, family activities, or team projects that can develop various mathematical reasoning and problem-solving skills in contexts that usually do not look like school math. Activities were originally designed for use by parents and kids together, and there are explanations on how to set up a family math program. Most activities and projects can be used as "openers" for adult classes or to extend more academic-oriented instruction.

Mathematics as problem solving.
[Contact: The Northwest Literacy Resource Center, 1701 Broadway, Seattle, WA 98122, phone: 800-238-1234.]

This two-part set describes a comprehensive 12-hour workshop for adult educators who want to enhance their math teaching skills. It was developed and field-tested by a team of adult educators associated with the Office of Community Colleges in Oregon and the Adult Basic and Literacy Education Network in Washington, and is based in part on: *Mathematics: Strategic Problem Solving*, a module developed by Pelavin Associates, Washington DC through federal funding from the U.S. Department of Education.

Burns, M. (1975). *The I hate mathematics book,* Boston: Little, Brown and Co. [Contact: Little, Brown and Co., 34 Beacon Street, Boston, MA 02106.]

Burns, M. (1976). *The book of think.* Boston: Little, Brown and Co.

Burns, M. (1977). *The good time math event book.* Palo Alto, CA: Dale Seymour Publishers. [Contact: Dale Seymour Publishers, P.O. Box 10888, Palo Alto, CA 94303.]

Burns, M. (1982). *Math for smarty pants.* Boston: Little, Brown and Co.

Available in most large bookstores, these books are geared toward teachers and parents of elementary and middle school students. The author gives specific suggestions, illustrates classroom dialogues, and comments on classroom processes. Wonderful and thought-provoking activities, and entertaining reading.

Stenmark, J. K. (1993). *Mathematics assessment.* Reston, VA: National Council of Teachers of Mathematics. (65 pages)
[Contact: NCTM, P. O. Box 25405, Richmond, VA 23260-5405, phone 800-235-7566.]

This accessible guide offers practical suggestions and models for implementing more authentic assessment for mathematics and for integrating assessment with instruction. Highly recommended for teachers who want a quick introduction to ways for extending methods that they use to evaluate students' learning and mathematical thinking.

Changing the rules. (1990). Syracuse, NY: New Readers Press. (25-minute video)
[Contact: New Readers Press, Box 131. Syracuse, NY 13210.]

A 25-minute video discusses several basic rules for reforming math education for adults, using live footage of an adult education class to demonstrate key ideas. A concise yet rich 16-page companion booklet discusses basic approaches to assessment, planning of instruction, and more.

Math basics. (1993-1994). Lexington: The Kentucky Network. (Video series)
[To purchase videotapes, contact The Kentucky Network Enterprise Division, 2230 Richmond Road, Suite 213, Lexington, KY 40502-7311. To receive via satellite, contact the PBS Adult Learning Service, phone 800-257-2578.]

A new TV and video series for adults who feel uncomfortable about learning and using math. De-emphasizes learning of rote calculations and instead focuses on thinking skills, estimation, and number sense. Comes with a textbook. This series is not cheap, but provides a cost-effective

alternative/supplement for staff development workshops. Portions can be shown to students and used repeatedly in many classes. *Ask for a preview tape and judge relevance for your students.*

Complete real life math series with word problems. (1993-1994). New York: Video Tutorial Service. (Video series)
[Contact: Video Tutorial Services, 7610 13th Avenue, Brooklyn, NY 11228, phone 718-745-8988.]
A 12-part video series that offers a comprehensive review of basic skills, beginning with fractions, decimals, and percentages, especially designed for students needing remedial help. The skits involve real-life situations such as paying rent, choosing a car loan, avoiding finance charges, balancing a checkbook, and selecting bargains. Interactive exercises and companion workbooks complement the visuals. The package is geared to teens, but could be used with (young) adults. *Ask for a preview tape and judge relevance for your students.*

Tobias, S. (1994). *Overcoming math anxiety*. New York: Norton.
Zaslavsky, C. (1994). *Fear of math: How to get over it and get on with your life*. New Brunswick, NJ: Rutgers University Press.
Written in an accessible language and available in many bookstores, these books are highly recommended for those who are interested in understanding the "baggage" that adults bring with them to life and school situations involving learning or using math. Both offer numerous ideas for assisting adults (and children) in overcoming prior negative experiences with math learning. Tobias has written extensively about how and why people develop negative beliefs and attitudes towards learning of math and science, and discusses results from interviews with adults and teachers and from visits to remedial programs. Zaslavsky is also building on her prior work in multicultural aspects of mathematics education.

Resources for Tutors and Tutor Training in Mathematics Teaching

Pomerance, A. H. (1993). *Adult literacy handbook for students and tutors* (Fourth edition). Philadelphia: Center For Literacy.
[Contact: Center For Literacy, 636 South 48th Street, Philadelphia, PA 19143, phone 215-474-1235.]
A thorough reference book for literacy tutors, with a good chapter on teaching mathematics. Following a "whole language" approach, many suggestions are offered for embedding writing, reading, and comprehension tasks within the teaching of math. While the booklet has been developed for tutors, most of the suggestions in the mathematics chapter will also be of interest to those teaching in a classroom context.

Math anxiety: A video guide. (1994). Philadelphia: Mayor's Commission on Literacy. (Video and 20-page booklet)
[Contact: Mayor's Commission on Literacy, 1500 Walnut Street, 18th floor, Philadelphia, PA 19102, phone 215-685-6602.]
This 20-minute video and accompanying aims to alleviate concerns reading tutors may have about their math-teaching skills. The video can be used in tutor training workshops or be viewed by both tutors and learners. The viewer guide lists tutoring hints and suggests "stop-points" where tutors (or students) viewing the video can discuss specific issues shown in the video. (Since this resource aims to cover only the first few tutoring sessions, it should be supplemented by other resources listed in this section.)

Kepner, H. S., & Johnson, D. R. (1977). *Guidelines for tutors of mathematics*. Reston, VA: National Council of Teachers of Mathematics.
[Contact: NCTM, P. O. Box 25405, Richmond, VA 23260-5405, phone 800-235-7566.]
This booklet, developed for tutoring students in a school context, provides a lot of sound advice and useful strategic suggestions that would help tutors of adults. The general frameworks and hints discussed in this booklet should be read as an introduction for the LVA booklet described next, which focuses mainly on the details of acquiring arithmetic skills.

Literacy Volunteers of America, Inc. (1982). *Basic math skills: A Handbook for tutors.* Syracuse, NY.
[Contact: Literacy Volunteers of America, 5759 Widewater Parkway, Syracuse, NY 13214.]
Designed for literacy tutors whose students also need assistance in basic math, this handbook aims to provide a gentle introduction for tutors who may be anxious about their math teaching skills. Explains how to develop a math sequence for introducing basic computation skills. Some

discussion of the similarities between teaching reading and math to help tutor orientation. Includes a simple written math screening/assessment tool. (Note: The booklet focuses on improving computational skills. It does a useful job in this regard, but should be used in the context of the broader resources described above because the skills that it focuses on are only a subset of the numeracy skills and dispositions outlined earlier in this Packet.)

Understanding Math in a Workplace Context:

Secretary of Labor's Commission on Achieving the Necessary Skills (SCANS). Washington, DC: Department of Labor.
[Contact the Government Printing Office, Superintendent of Documents, Mail Stop: SSOP, Washington, DC 20402-9329, phone 202-783-3238, and indicate the order numbers listed below.]

1. *What work requires of schools.* (1991). (90 pages) Order No. 029-000-00433-1
2. *Learning a living, part 1.* (1992). (90 pages) Order No. 029-000-00439-1
3. *Learning a living, full report.* (1992). Order No. 029-000-00440-4
4. *Lo que trabajo necesita de las escuelas.* (90 pages) Order No. 029-000-00441-2
5. *Skills and tasks for jobs.* Order No. 029-000-00437-4
6. *Teaching the SCANS competencies.*(1993). Order No. 029-000-00438-2

The SCANS reports provide an overview of all skills needed in high-performance workplaces, and touch on math in this context. However, the basic premise of SCANS is that math skills, as well as most other basic skills, are used in an integrated fashion at work. Thus, you will not find specific sections addressing only math. The reports are all highly readable, contain concrete examples for workplace activities, and are an excellent introduction for educators who seek to provide a "generic" work preparation for adult students. If you do not want to order all of them, start with #1 and #2, which serve as a foundation for the other reports. Next, order #6, which is oriented towards instruction.

Carnevale, A. P., Gainer, L. J., & Meltzer, A. S. (1990). *Workplace basics: The essential skills employers want.* San Francisco: Jossey-Bass.
[Available in many university libraries, or through a special order in most bookstores.]
This interesting book is based on a project conducted by the American Society for Training and Development (ASTD) in the late 1980s, under funding from the U.S. Department of Labor. Based on extensive interviews with employers, industrial trainers and human resource personnel, the ASTD team has developed a framework describing the skills that employers want, and has included a specific chapter on math and computational skills in the workplace. (For readers who wonder, the SCANS reports relied on the Carnevale et al. work as well as on SCANS' own inquiries and studies to inform K-12/adult education (as opposed to workplace training, which was the primary focus of this ASTD project).

1995 NCTM Regional Conferences	
February 9-11	Birminghman, AL
March 2-4	Chicago, IL
October 5-7	Grand Rapids, MI
October 12-13	Springfield, MO
November 29-December 1	Philadelphia, PA
NCTM 73rd Annual Meeting	
April 6-9, 1995	Boston, MA

Adult Numeracy Instruction: A New Approach

Part C: Electronic Resources

Section 9. Electronic Resources for Adult Numeracy.

In order to facilitate continued dialogue among videoconference participants and to assist practitioners in the discovery of numeracy resources on the Internet, we are encouraging you to participate in follow-up electronic on-line activities. Information follows on the resources available electronically that are relevant to adult numeracy and adult literacy and on how to gain access to electronic networks and the Internet.

Using the Adult Numeracy LISTSERV

The Adult Numeracy Practitioner Network (ANPN), in cooperation with the National Center on Adult Literacy (NCAL), will hold a series of discussions about the videoconference and related topics in adult numeracy using ANPN's NUMERACY LISTSERV. NUMERACY is an electronic mailing list for members of the ANPN and others interested in discussing educational issues related to adult mathematical literacy. ANPN encourages ABE, GED, ESL, and workplace literacy teachers, tutors, and adult learners to freely meet in this electronic forum to share the challenges, problems, insights, and rewards of teaching and learning adult math and numeracy skills. Each week for four weeks after the videoconference, NCAL and/or ANPN staff will send out a message to the NUMERACY LISTSERV requesting comments on issues raised during the videoconference and providing new information about adult numeracy resources that subscribers have discovered.

What Is a LISTSERV and How Do I Join NUMERACY?

LISTSERVs are e-mail-based systems that allow interactive communication. Unlike regular e-mail communication, which allows one-to-one communication, LISTSERVs allow one-to-many communication. To participate in a LISTSERV, one must first subscribe by sending an e-mail message to a special address with a "subscribe" statement in the body of the message. To subscribe to the NUMERACY LISTSERV, send e-mail to

majordomo@world.std.com

leaving the subject field blank or, if your system requires you to specify a subject, with the word None as the subject. In the body, enter

subscribe NUMERACY [user's e-mail address]

Please note: On some LISTSERVs, one might add a first and last name after NUMERACY in this case, only add your e-mail address after NUMERACY. Anyone with an Internet e-mail account can participate in a LISTSERV, including users of America Online, Delphi Internet Services, CompuServe, GEnie, OTAN, and any Freenet.

Once subscribed, users hold interactive discussions on issues by sending e-mail messages to a designated e-mail address. For instance, if you wanted to send a message to the subscribers of NUMERACY asking for their opinions of the methods discussed in the videoconference, you would compose the question in a regular e-mail message and address it to

numeracy@world.std.com

When the computer (in this case, world.std.com) receives the message, it immediately "reflects" it back to all the NUMERACY subscribers. In a few minutes the message will appear in all the subscribers' e-mail boxes. Subscribers can then forward their responses to all of the NUMERACY subscribers by composing a new message and sending it to the same e-mail address, numeracy@world.std.com. It is customary for correspondents, when referring to previous messages, to copy part of the original message in their reply so that all subscribers have a sense of the context in which the reply was generated.

If you want to stop receiving message from NUMERACY, send an e-mail message to

majordomo@world.std.com

leaving the subject field blank or, if your system requires you to specify a subject, with the word None as the subject. In the body, enter

unsubscribe NUMERACY

with no text after NUMERACY. You may rejoin at any time by repeating the process described above.

Section 10. Additional Electronic Resources for Adult Numeracy and Literacy.

Below are listed several Internet Gopher servers and LISTSERVs that are relevant to adult numeracy. For more information about getting connected to or using the Internet, please see the participant packet for the videoconference *Technology: New Tools for Adult Literacy.*

Internet Gopher Servers

National Center on Adult Literacy **Address:** litserver.literacy.upenn.edu
Distributes research reports, newsletters, and other information resources prepared by the National Center on Adult Literacy.

- Research reports on adult numeracy
- Research reports on other topics in adult literacy
- Archive of shareware/freeware for use in adult numeracy programs
- Database of commercial adult literacy software
- Archives of messages to adult numeracy LISTSERVs
- Conference announcements
- Links to other math-oriented and adult literacy-oriented Gopher servers

American Mathematical Association **Address:** e-math.ams.org
Distributes the American Mathematical Society's work at all levels of education, including adult.

- Instructional material, which could be adapted for use with adults
- Publications
- Conference announcements
- Professional information
- Links to other math-oriented Gopher servers

Mathematical Association of America **Address:** gopher.maa.org
Focuses on math at the college level, but also contains information applicable to adult numeracy.

- Mathematical news, including conference announcements, reports, and recent research
- Teachers, aids
- Publications
- Links to other math-oriented Gopher servers

AskERIC: Educational Resource Information Center **Address:** ericir.syr.edu
General educational information center that can be searched for math-related information. ERIC is continually being updated and revised.

- Lesson plans
- Bibliographies
- News and announcements
- ERIC digests and full length articles
- Electronic books, journals, and reference tools
- Links to other education resources and gophers

University of Tennessee, Mathematics Archives **Address:** archives.math.utk.edu
Although this Gopher contains information appropriate primarily for college-level instruction, many of the lesson plans and some of the software could be adapted for use with adults.

- Lesson plans
- Extensive archives of math-related instructional software
- Review of commercial math-related instructional software
- Links to other math-oriented gophers

Common Knowledge **Address:** gopher.pps.pgh.pa.us

Although designed for K-12 practitioners, this extensive collection of curriculum resources includes many items useful for mathematical education of adult numeracy students.

- Lesson plans
- Information about the use of Mathematica and other programs for K-12 and college
- A list of Internet sites with math education software
- Links to other math-oriented gophers

E-Mail LISTSERVs

FAM-MATH: Family Math List

To join the list and receive the mailings from FAMILY MATH LIST, send a message to: LISTSERV@uic.edu (make the subject None), saying: subscribe FAM-MATH "your full name here"

For example:

To: LISTSERV@uic.edu
Subject: None
Message: subscribe FAM-MATH John Doe

(Note: Please put your name in place of "John Doe")

To submit a message to FAM-MATH, send the e-mail message to: FAM-MATH@uic.edu

Family Math is a new newsletter on issues in family mathematics instruction and has the potential to become a valuable resource as the list gains members.

NCTM-L: National Council of Teachers of Mathematics

To join the list and receive the mailings from NCTM-L, send a message to: LISTPROC@sci-ed.fit.edu (make the subject None), saying: subscribe NCTM-L "your full name here"

For example:

To: LISTPROC@sci-ed.fit.edu
Subject: None
Message: subscribe NCTM-L John Doe

(Note: Please put your name in place of "John Doe")

Although this list is primarily used by K-12 practitioners, it is a tremendous source of ideas about the teaching of mathematics that can help practitioners at all levels of education.

AEDNET: Nova University

To join the list and receive the mailings from AEDNET, send a message to: LISTSERV@alpha.acast.nova.edu (make the subject None), saying: subscribe AEDNET "your full name here"

For example:

To: LISTSERV@alpha.acast.nova.edu
Subject: None
Message: subscribe AEDNET John Doe

(Note: Please put your name in place of "John Doe")

To submit a message to AEDNET, send the e-mail message to: AEDNET@alpha.acast.nova.edu

The Adult Education Network (AEDNET) is an international network of individuals interested in adult education. The network is operated through a LISTSERV that enables subscribers to share information. Researchers, practitioners, and graduate students in adult and continuing education are provided with opportunities to discuss important topics and concerns in an on-line environment.

AEDNET is operated by the Adult Education Program of the Programs for Higher Education of the Abraham S. Fischler Center for the Advancement of Education at Nova Southeastern University located in Fort Lauderdale, Florida. AEDNET activities include network-wide discussions and information exchanges on topics and queries, conferences, and special events of interest to adult and continuing educators. Also, a refereed electronic journal, *New Horizons in Adult Education*, is distributed through AEDNET.

LITERACY: NYSERNET

To join the list and receive the mailings from LITERACY, send a message to: LISTSERV@nysernet.org (make the subject None), saying: subscribe LITERACY "your full name here"

For example:

To: LISTSERV@nysernet.org
Subject: None
Message: subscribe LITERACY John Doe

(Note: Please put your name in place of "John Doe")

To submit a message to LITERACY, send the e-mail message to: LITERACY@nysernet.org

LITERACY is a moderated general discussion group for those individuals concerned with the issues of literacy. It is hoped that the group will foster discussion by those involved in teaching adults to read and write. It is also open to anyone who is interested in the topic of literacy in general. Discussion of such topics as family literacy are welcome. The sharing of ideas, tips, helpful resources, teaching tools, and personal experiences are all to be encouraged.

The primary goal of the list is the fostering of literacy in those adults for whom English is the native language, but who, for any number of reasons, never learned to read or write. It is acknowledged that the learning of English as a second language is also considered a literacy issue, but the specific concerns of this issue are beyond the scope of this list. Of course any general literacy discussion issues that happen to arise from the teaching of English as a second language are welcome.

Section 11. Electronic Adult Numeracy Resources: Getting Connected.

Despite the growing popularity of the Internet as a telecommunications tool, finding a service provider that offers individuals or organizations access to the Internet is still not easy. There are three ways to gain access to the Internet: via a high-speed institutional (i.e., university, government, library, etc.) connection, through community-based dial-up systems generically called Freenets, or through a commercial dial-up access provider. There are literally hundreds of Freenets and commercial access providers. If you would like a full list, please order the participant packet for the first videoconference, *Technology: New Tools for Adult Literacy,* from NCAL. Of the commercial services that offer individuals and organizations low-cost, modem-based access to the Internet, America Online and Delphi Internet Services are the largest. Below you will find basic information about subscribing to these services. America Online (AOL) is the recommended access provider because it offers 10 free hours of service to new users, has an easy-to-install and easy-to-use interface, and has several proprietary information resources and communications groups devoted to adult literacy.

Note: The sponsors of this videoconference neither support nor endorse the use of any of the on-line services mentioned in this document; any recommendations are for informational purposes only.

To connect to either America Online or Delphi Internet Services, you will need to have, at minimum, the following equipment: a personal computer and a modem (a device that allows computers to exchange data with one another via plain phone lines). If you need more information about setting up your computer to access the Internet or if any of the terms used below are unfamiliar, please order the participant packet that accompanied *Technology: New Tools for Adult Literacy* or contact the access provider that you are planning to use.

America Online
Phone: 1-800-827-6364

Subscribing

If you are not already a member of America Online (AOL), do the following:

1. If you or your program has more than one computer, decide which computer will be used to dial into America Online.
2. If you do not have them, order a modem and cable. Preferably, the modem should operate at 9,600 or 14,400 bps. However, the modem MUST be compatible with the Hayes AT command set (the modem package should say something to the effect of "Hayes Compatible" or "100% Hayes Compatible"; if you have questions, consult with the store where you plan to buy the modem).
3. If you have an IBM, find out how much random access memory (RAM) your computer has, how large the hard drive is, what type of video adapter it uses, the version of DOS you use, and (if applicable) the version of Windows used. If you have a Macintosh, determine how much RAM memory you have, how large your hard drive is, and the version of the system software you use.
4. Call America Online at 1-800-827-6364. Provide the sales representatives with the information about your computer that you collected earlier and ask them whether America Online's software will work with your system. If not, ask them what you would have to add to your computer in order to make it work properly with America Online. America Online will ship you the software necessary to subscribe to America Online in 10-14 days. If you need help with any aspect of using AOL, call the number listed above.

   IMPORTANT: When you subscribe to America Online, the system will request your credit card number. America Online provides you with 10 hours of free service during the first 30 days you are subscribed to the system. When the initial 10 hours are used or after 30 days, subsequent connections to America Online will be charged to your credit card. We encourage you to monitor your on-line time carefully if you intend only to take advantage of the free time and do not intend to continue your subscription. The sponsors of this videoconference have not purchased connection time from America Online and are not responsible for usage charges arising from participation in any of the on-line follow-up activities.

Using America Online's Internet Features

AOL's Internet features, including e-mail, the USENET bulletin board (AOL calls USENET "Newsgroups"), Gopher/WAIS databases, and FTP are located in AOL's Internet Center. You can find the Internet Center by using the "Keyword" option in the "Go To" menu. For more information on using AOL generally and AOL's Internet tools specifically, we recommend purchasing the *America Online Tour Guide* from AOL and Ventana Press.

Delphi Internet Services, Inc.
Phone: 1-800-695-4005

Subscribing

If you are not already a member of Delphi Internet Services, do the following:

1. If you or your program has more than one computer, decide which computer will be used to dial into Delphi.
2. If you do not have them, order a modem and cable. Preferably, the modem should operate at 9,600 or 14,400 bps. However, the modem MUST be compatible with the Hayes AT command set (the modem package should say something to the effect of "Hayes Compatible" or "100% Hayes Compatible"; if you have questions, consult with the store where you plan to buy the modem).
3. If your modem did not come with terminal emulation software (software that controls the modem and allows you to communicate with Delphi), you will need to purchase it from a software vendor. The most popular packages for IBM compatibles is ProComm 2.4 from DataStorm and SmartCom from Hayes Microsystems. On the Macintosh, the most popular packages are MicroPhone Pro from Software Ventures and SmartCom II from Hayes Microsystems. You will need to become familiar with the software before attempting to connect with Delphi. Specifically, become familiar with the stop bit, data bits, and parity settings in the software. The software's manual should help you sort out these settings.
4. Call Delphi at 1-800-695-4005. The sales representative will give you a user name and password, which will allow you to log into the system. Also ask the sales representative to give you the parity, data bits, and stop bit settings for your modem software.

IMPORTANT: When you subscribe to Delphi Internet Services, the system will request your credit card number. Delphi provides 5 hours of free service during the month in which you subscribe. When the initial 5 hours are used or at the end of the month in which you initiated your subscription, subsequent connections to Delphi will be charged to your credit card. We encourage you to monitor your on-line time carefully if you intend only to take advantage of the free time and do not intend to continue your subscription. The sponsors of this videoconference have not purchased connection time from Delphi Internet Services and are not responsible for usage charges arising from participation in any of the on-line follow-up activities.

Using Delphi's Internet Features

To use any Internet services, you must first register as an Internet user. Delphi charges an additional $3 per month for access to Internet tools. To register as an Internet user:

1. Log in.
2. Enter "Terms" and hit return. This will take you through the terms of use for Delphi's Internet service. Be sure to read this document before continuing.
3. Enter "Register" and hit return.
4. Enter "Exit" and hit return. This will leave you in Delphi's Internet special interest group (SIG). Entering "Exit" and hitting return a second time will return you to the main menu.

Adult Numeracy Instruction: A New Approach

Appendix: Ice Cream Problem

Ice Cream Problem

The situation: You have been asked to manage a local ice cream store. It is a very small operation that has been losing money. The owner of the store thinks that the store may have been offering the wrong flavors of ice cream, and that sales could be improved by offering more popular flavors.

For your first order, the ice cream distributor will deliver 40 containers of ice cream to your store. You must decide what flavors to order and how many containers of each kind. Your display case holds ten containers of ice cream, so you can offer up to ten flavors at a time, and you probably want to offer enough variety to satisfy your customers. The other 30 containers will be stored in a back room storage (see enclosed drawing). Each container is about 3 gallons and yields 50-60 scoops of ice-cream.

What you have to do: Decide what flavors to order and how many containers of each flavor. (You may use the enclosed newspaper article with the pie chart and data to help you decide. Be prepared to later on explain your decision and your reasoning process).

Available Flavors:

Chocolate
Vanilla
Strawberry
Raspberry
Black Cherry
Peach
Lemon
Coffee
Vanilla Fudge Swirl
Butter Pecan
Pralines and Cream
Swiss Chocolate Almond
Pistachio
Heath Bar Crunch
Oreo Cookie
Chocolate Chip
Mint Chocolate Chip
Rocky Road
Bubble Gum

What's the Scoop?

By GEORGE LYONS

America leads the world in per capita production of ice cream. According to the International Ice Cream Association, in 1993, U.S. ice cream production exceeded 1.5 billion gallons, which translates to an average of 23.6 quarts per person.

A survey conducted by the IICA found that while chocolate was once the second most popular flavor of ice cream, it now accounts for only 8 percent of all retail ice cream sales.

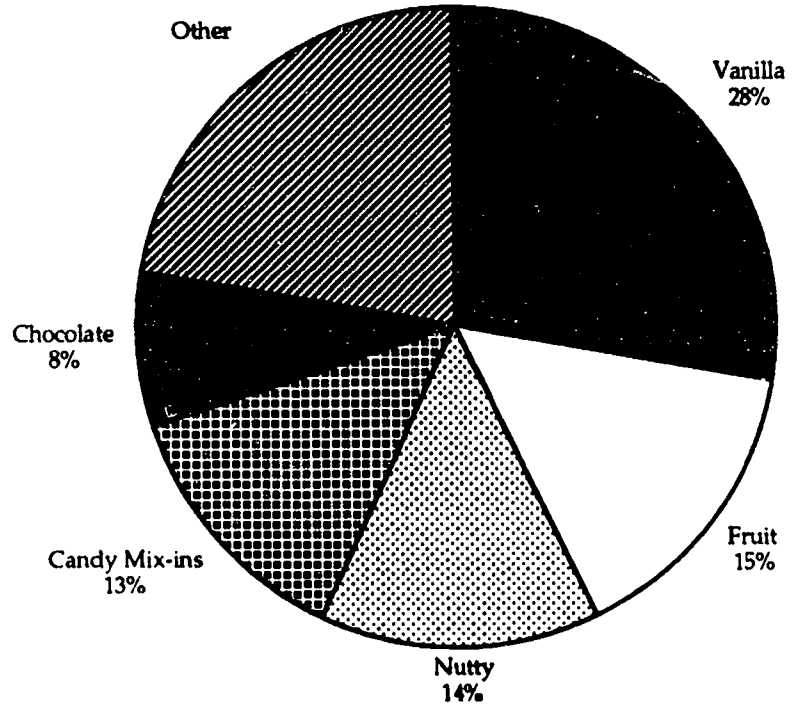
Vanilla remains the most popular flavor at 28 percent of ice cream retail sales, followed by fruit flavors at 15 percent and candy mix-in flavors at 13 percent. The leading toppings are hot fudge and chocolate fudge.

At the local Yummy Ice Cream Shop there is quite a range of exotic flavors to choose from, everything, it seems, but plain chocolate.

"Flavors that have chocolate sell more than plain chocolate," said the owner, Jean Baker. "I think people are looking for the unusual and that's what we try to provide here." Her best sellers are raspberry chocolate chip, Oreo cookie, and, of course, plain vanilla.

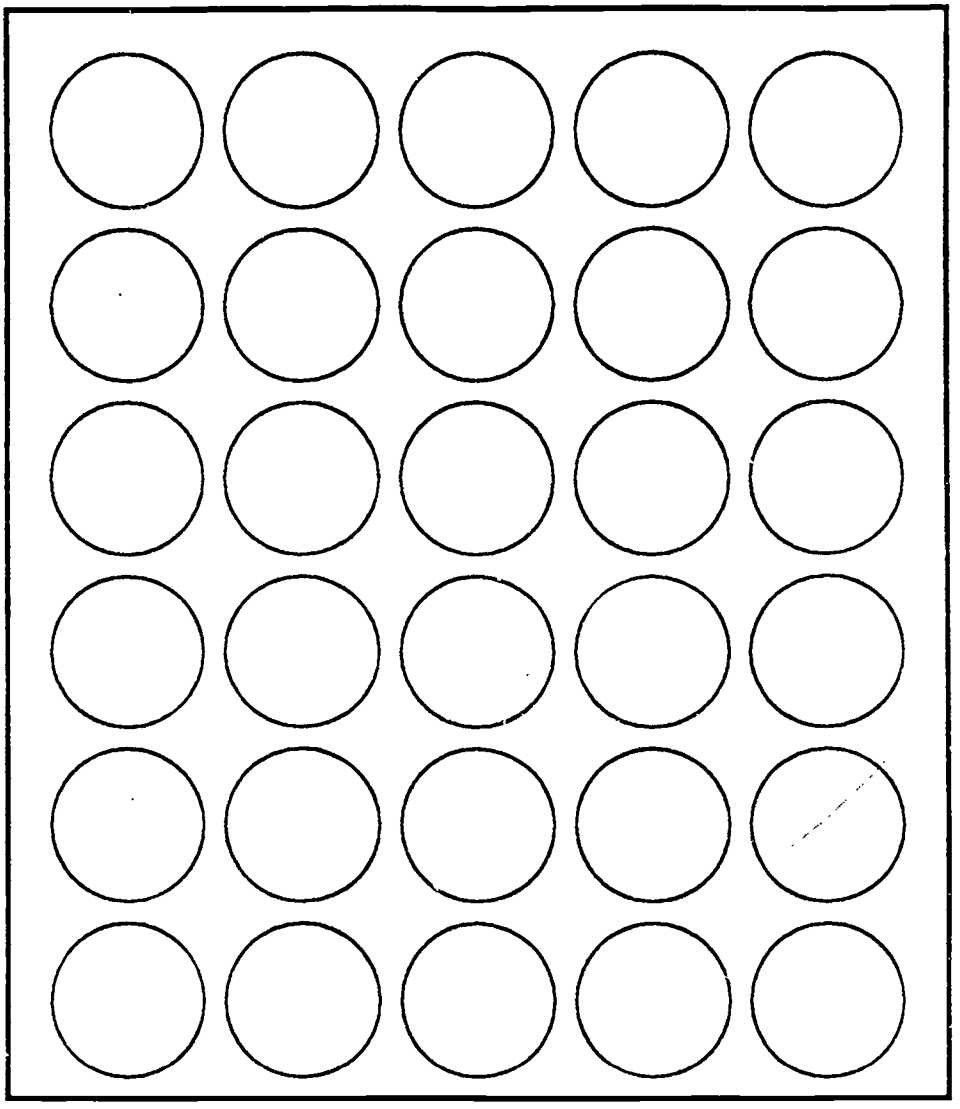
Top Ice Cream Flavors

Based on retail sales in 1993



Source: International Ice Cream Association

Ice Cream Storage (30 containers)



Display (10 containers)