Adult Basic Skills Professional Development Manual

Numeracy

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Appalachian State University
North Carolina Community College System
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Acknowledgments

The Adult Basic Skills Professional Development Manual: Numeracy was made possible through the collaboration of many individuals who generously shared their expertise from years of teaching mathematics in adult education. To them we extend our heartfelt gratitude. In addition, we extend our appreciation to the countless people serving in numeracy roles across the state.

We thank the North Carolina Community College System for its financial and professional support. We extend thanks to President Martin Lancaster, Dr. Randy Whitfield, Ms. Linda Ray, Ms. Katie Waters, Ms. Sillar Smith, Mr. Robert Allen, and Ms. Lou Ann Parker for continued contributions to the Adult Basic Skills Professional Development Project.

Without the contributions of the Adult Basic Skills directors, instructors, and trainers this manual would be incomplete. We extend to each a hardy "Thank You!" for their input.

A special thanks goes to Institute 2004 participants who contributed to the training and teaching plans and to Elizabeth Johnston, Nathan Karner, Jenna McNeill, and David Thompson who worked as editorial assistants.

The ABSPD Project also owes a debt of gratitude to our Advisory Council members for their guidance in making decisions on the best means to meet the needs of Adult Basic Skills instructors and students. The members of the 2004-2005 Advisory Council are:
Robert Allen, NC Community College System
Sabra Barfield, Brunswick Community College
Linda Battle, Nash Community College
Keith Clayton, Fayetteville Technical Community College
Mike Davis, Isothermal Community College
Kathy Gardner, Stanly Community College
Leo Kelly, Jr., Vance-Granville Community College
Sandra Loyer, Catawba Valley Community College
Sharon McGinnis, Coastal Carolina Community College
Michele Meischeid, Roanoke-Chowan Community College
Patricia Phillips, Davidson County Community College
Lou Ann Parker, NC Community College System
Linda Ray, NC Community College System
Sillar Smith, NC Community College System
Vicki Tate, Robeson Community College
Katie Waters, NC Community College System
Frances Wheeler, Western Piedmont Community College
Randy Whitfield, NC Community College System

Without the dedication and skill of these wonderful people, this manual would not be possible. Thank you, Advisory Council.
Preface to Trainers and Instructors

Cheryl S. Knight

The purpose of this manual is to provide research-based information on planning and presenting high-quality interactive numeracy training to meet the professional development needs of Adult Basic Skills professionals. Much research and experience in providing numeracy training for Adult Basic Skills professionals precedes its writing.

This inviting manual is reader friendly. Margins and white spaces provide areas to record reflections, notations, and adaptations. The manual’s efficacy as a reference encourages customization to meet your needs.

The field of numeracy training and instruction continually advances. Theories change, new technology develops, and the descriptive terminology evolves. However, basic elements persist within the changing environment. This manual presents fundamental research-based strategies proven to be effective for numeracy instruction and professional development for Adult Basic Skills educators.

This manual is divided into three parts and 17 chapters organized with headings and sub-headings to guide reading. Included are suggestions to help users make the transition from instructor-centered teaching to student-centered activity-based learning.

The Need for Numeracy emphasizes how we use numbers and logical reasoning every day without recognizing what we are
doing. With this in mind chapter 1 discusses the concept of numeracy, its goals, and importance. Chapter 2 deals with math anxiety and the impact that fear and excuses make on the ability to learn and apply numeracy skills. Since learner characteristics greatly affect outcomes in mathematics’ classes, chapters 3 and 4 address distinctions and similarities among adults and how instruction should be designed to meet the variety of learning styles they bring to our classes. Since effective teaching requires learning substantial information chapter 5 gives ideas for teaching content. Numeracy lends itself well to hands-on, manipulative learning; textbooks have never effectively represented numeracy skills for some adult learners. Chapter 6 teaches the use of realia, or authentic materials, situations, and problems, to teach numeracy skills, giving meaning and application to concepts as they are learned. An integrated approach to teaching numeracy is through the project-based method which emphasizes the need to integrate the learning of numeracy skills with other subject matter while making application to a problem or project. Complete details for application are found in chapter 7. One numeracy instrument that has made its way into purses, pockets, and pouches is the calculator, yet many people do not know how to use it to make their lives simpler. Chapter 8 serves as an easy to understand guide on how to use the calculator. Portions of the chapter may even be shared directly with learners. Chapters 9 through 15 use information from previous chapters, combined with new material to generate professional development plans for training Adult Basic Skills trainers and instructors in the fundamentals of numeracy instruction. To be in tune with today’s world the manual has included chapter 16, Internet Resources. A glossary of mathematical terms comprises chapter 17, which is followed by an extensive bibliography. It is our goal that this manual serves you and your students well as a guide to the teaching of numeracy.

Use this manual extensively to make your workshop facilitation and classroom instruction efficient and effective. Regardless of the model employed, planning is the most important aspect of success. The better prepared you are, the more effective you will be as a trainer and/or instructor.
This manual is the 10th in the Adult Basic Skills Professional Development Instructor Training Manual Series. The content of each manual is intended to enrich the user’s knowledge base and provide opportunities for professional development. For a complete listing of training manuals, videos, and CD-ROMs visit our web site at www.abspd.appstate.edu.
Part 1

Research, Theory, and Practice
The Need for Numeracy

Dianne B. Barber

The harmony of the world is made manifest in Form and Number, and the heart and soul and all poetry of Natural Philosophy are embodied in the concept of mathematical beauty.

D’Arcy Wentworth
Introduction

“It is far easier to calculate a percentage than it is to drive a car” (Dewdney, 1993, p. 1). However, many people think the words “math” and “simple” do not belong in the same sentence. Math has such an aura of difficulty surrounding it that even people who are quite competent in other areas of life are not ashamed to admit they cannot “do” math. Innumeracy is more socially acceptable and tolerated than illiteracy (Dewdney, 1993; Withnall, 1995).

Math inundates our days. For instance, adult students begin each day by calculating the time needed to get to work or accomplish a particular task, and they continue using math throughout the day. In our society most days include one or more purchases which usually require the calculation of whether one has enough money to make a purchase, how much tax will be added, and how much change will be returned. Periodically, each of us calculates how much paint, fertilizer, or other materials are required, but usually, after we calculate the area to be covered. Many of us cook on a daily basis and sometimes follow recipes. These activities require numeracy skills.

Just as literacy has become increasingly important in our society, so has numeracy. We are exposed to numerical data every day, through sales pitches, budget considerations, shopping and buying, and most occupations including homemaking. Many of us do math routinely without realizing we are doing math, such as when we estimate lengths, areas, volumes, or total costs. These applications of math provide an obvious source for illustrations of the importance of math to everyone. Practical problems tend to inspire and maintain student interest in math.
Everyday tasks, as well as many occupational uses, provide a wealth of examples both to show the value of math and to provide practical applications for encouraging students in developing numeracy skills. Adult students expect practicality in learning. The Adult Basic Skills instructor must provide practical examples to inspire and involve students, followed with sufficient practice to develop appropriate numeracy skills. Using everyday applications greatly increases the chance of success in learning mathematics.

**What is Numeracy?**

Numeracy is more than being proficient at basic math calculations. According to Withnall, “Numeracy is the type of math skills needed to function in everyday life, in the home, workplace, and community” (1995). In the book, *Adult Numeracy Teaching: Making Meaning in Mathematics*, numeracy is described as

>a critical awareness which enables us to build a bridge between mathematics and the real world, with all its diversity. Being numerate also involves the personal responsibility of reflecting that same critical awareness in one’s social practice. Thus, being numerate means being able to situate, interpret, critique, and use math in context, taking into account all the mathematical as well as social and human complexities which come with that process. (Johnston, Agars, Marr, Tout, & Yasukawa, 1998, p. 234)

Numeracy requires a range of problem solving skills that allow citizens to function in a free enterprise society. Even hobbies and leisure activities require, or at least are enhanced by, basic mathematical skills. Cooking, gardening, and home improvement are common activities that illustrate math applications. Researchers in the field of ethnomathematics demonstrate that all cultures recognize mathematical concepts and use them, much as language is recognized and used, as a system for making meaning of the world (Numeracy in Focus, 1995).
“Numerate behavior is observed when people manage a situation or solve a problem in a real context; it involves responding to information about mathematical ideas that may be represented in a range of ways; it requires the activation of a range of enabling knowledge, behaviors, and processes” (Gal, van Groenestign, Manly, Schmitt, & Tout, 1999, p. 11). Different people require different sets of math skills, and their numeracy needs change in response to changes in life circumstances, such as buying a car or house or learning a new hobby (Gal, 1993; Withnall, 1995). Like literacy, numeracy “is not a fixed entity to be earned and possessed once and for all” (Steen, 1990, p. 214), nor a skill one either has or does not have. Instead people’s skills are situated along a continuum of different purposes and levels of accomplishment with numbers (Kerka, 1995).

Schmitt (2000) reported the following:

Numeracy has to do not only with quantity and number but also with dimension and shape, patterns and relationships, data and chance, and the mathematics of change. Adult Basic Education and General Education Diploma (GED) mathematics instruction should be less concerned with school mathematics and more concerned with the mathematical demands of the lived-in world: the demands that adults meet
in their roles as workers, family members, and community members. Therefore we need to view this new term, numeracy, not as a synonym for mathematics but as a new discipline defined as the bridge that links mathematics and the real world. Adult Basic Education and GED mathematics instruction need to draw upon what is known about the development of children’s mathematical thinking and extend that research to address the development of adults’ numerate thinking and practice. (p. 4)

According to Glass (2001):

The communication skills associated with literacy may be refined into such categories as listening, speaking, reading, and writing. This facilitates the creation of a more manageable framework for delivering those literacy skills. Similarly, the concepts and skills associated with numeracy necessarily become much further qualified. Different “categories” or “subdivisions” of numeracy emerge to allow for the creation of a manageable, sensible framework for delivering numeracy education. In a general sense, Steen identified five categories of numeracy, each linked directly to its use or application. These include practical numeracy, civic numeracy, professional numeracy, numeracy for leisure, and cultural numeracy. (p. 13)

Similarly, John Dingwall, in his March 2000 report, Improving Numeracy in Canada, identifies five purposes for numeracy:

- everyday-life,
- community,
- work-related,
- personal organization, and
- further learning.
Numeracy includes major and lasting educational skills and concepts that contribute to successful functioning in society. It is an aggregate of skills, knowledge, beliefs, attitudes, problem solving skills, and communication skills that enable people to effectively handle real-world situations. Therefore, adults need to seamlessly integrate their use of mathematical skills with linguistic or communicative skills. Careful observation of the world around us makes that obvious and can help students refute the rather popular image of math as something incomprehensible and often irrelevant.

**Goals of Numeracy Education**

The Adult Basic Skills math instructor should approach every class preparation, as well as instruction, with an acute awareness of the students’ needs for numeracy. The teaching of computation skills should be embedded in a practical application approach that enhances students’ abilities to understand and communicate math.

Yasukawa, Johnston and Yates (1995) listed the following seven general aims in numeracy education:

1. Make explicit the concept of mathematics as a social construction through engaging both presenter and participants in a negotiated process of constructing a blueprint to realize the educational objectives.

2. Develop an appreciation that individual human construction of knowledge is a sub-process of, but not equivalent to, social construction of knowledge.

3. Reinforce the value of reflective practice as a way of enriching personal knowledge as well as the learning environment.

4. Develop an awareness of the political nature of numeracy, and the sensitivity to power required in the practice of engendering numeracy in and out of a classroom.
5. Critically examine the politics of ‘content and coverage’ versus ‘meaning and connections’ in teaching and learning environments.

6. Critically analyze the relationships and interactions between teachers’ and learners’ views of mathematics and numeracy, their espousal and their enacted models of learning and teaching, and the factors influencing them.

7. Become familiar with more areas of mathematics as they emerge and become resourceful in the process of learning math.

Incorporating these goals into lesson planning contributes significantly to the learning of math and numeracy by Adult Basic Skills students. It makes math more interesting. It enhances learning by serving as a student tool for prying out strongly held beliefs that they “can’t do math.”

**Why Is Numeracy Important?**

John Dingwall (2000) identified numerous aspects of, and needs for, numeracy in a report entitled *Improving Numeracy in Canada*. The following items were included in his list:

1. **Economy and Workplace.** In the economy, some of the key driving factors for the increased use of numeracy are:
   - Widespread use of networked computers into which there is a constant flow of data, e.g., from “sensors” such as scanners at check-out counters. This information is collected and analyzed using databases, spreadsheets, and “business intelligence” and other reporting tools. All of this requires high degrees of numeracy on the part of everyone concerned.
Concern for quality in both manufacturing and services. This involves the use of data for control and analysis.

Availability of more information through the Internet, e.g., in areas such as comparative pricing (where buyers must analyze competitive prices and merits of different products and services).

Increasing knowledge content in all areas, most notably in the trades and professions, but also in many other fields; much of this knowledge has a mathematical or numerical dimension.

Increased teamwork. In teams, people need to develop and exercise a wider range of skills, e.g., planning, budgeting, scheduling, and process control.

2. **Personal Life.** Numeracy is also becoming more important in personal life, in areas such as:

- Budgeting and money management. Numeracy has always been important, but now the choices are more numerous and complicated.

- Health. Numeracy helps in understanding health related information, e.g., in areas such as medications, health risks, diet, and exercise. Increasingly, the discussion of these matters involves numbers. An example would be the increasing number of references to fat grams and the body mass index, a new subject within the past ten years.

- Household. Numeracy has always been important in home repairs and in renovation and construction. In recent years, there has been a vast expansion of “do it yourself” products and services. There is a wider range of choices in products and services and comparison shopping is becoming ever more complex.
Family. Many parents want to help children with math homework that seems to have become more challenging in recent years.

3. **Education and Knowledge.** Numbers and math are becoming more important in all areas of knowledge.

4. **Citizenship and Public Life.** As citizens, taxpayers, and stakeholders, people need to understand math and numbers, e.g., in discussions of taxes, expenditures, interest rates, employment levels, public opinion polls, and elections.

**Summary**

Unfortunately, our society popularizes the misconception that it is okay not to be able to do math; many otherwise very literate people almost seem to brag in those terms. Of course, numeracy is essential in everyday life. Adult students need to be encouraged to set goals and develop motivation. Reference to the everyday applications of math and numeracy, as well as to the opportunities to enhance hobbies, occupations, and family welfare by developing numeracy skills, can encourage the development of appropriate goals. Allow adult students to search for meaning and discover relationships between prior competence and new learning.

**Numeracy includes major and lasting educational skills and concepts that contribute to successful functioning in society. It is an aggregate of skills, knowledge, beliefs, attitudes, problem solving skills, and communication skills that enable people to effectively handle real-world situations.**
Dealing with Math Anxiety

Dianne B. Barber

Multiplication is vexation,
Division is just as bad;
The Rule of Three perplexes me,
And Practice drives me mad.
Old Rhyme
Introduction

Many Adult Basic Skills students have experienced failure in mathematics. Adult Basic Skills instructors across the state often tell me that math stands in the way of their students completing their GED. For too long, our society has excused math failure with statements like: “My parents couldn’t do math either,” “Most people that learn math never use what they learn,” or “A lot of very successful people can’t do math.” **Students will not learn what they are not expected to learn.** It is no wonder that so many careers are limited by inadequate understanding of mathematics.

College students often let math requirements govern their choice of majors thus restricting their career choices. People who would like to change careers often do not because they lack certain math skills and lack confidence in their ability to master them.

Imagine how people at a dinner party would react if someone admitted he/she could not read; picture how differently the same people would react to someone claiming he/she could not do math. The tragic fact that Americans practically brag about their abilities in math at least enhances, if not actually causes, rampant math anxiety.

Many students in the Adult Basic Skills numeracy classroom are convinced that they are not good in math, a conviction that is usually the result of a history of painful and embarrassing failures, ultimately justified by one or more of the quotes given in the first paragraph. This means that adult students are doomed to failure in the classroom unless they can be shown how they can learn. One of the most challenging, but potentially most satisfying, tasks for an Adult Basic Skills instructor is to guide students from the mistaken belief that they “can’t do math” to the truth that it is possible, rewarding, and even enjoyable to be able to use this vital tool in everyday life.

Math anxiety not confronted may lead to frustration which may result in failure.
Math Anxiety


Consider the elementary classroom environment where math work consists of repetitive calculations that seem to have no application to the real world and where perfection is demanded. Compound this image by picturing the first student to complete the problem being regularly recognized, while other students are left feeling inferior. Imagine a teacher who has no patience with those who do not catch on quickly, or a teacher whose personal dislike for math is made obvious by omitting math instruction or otherwise giving math a low priority. Many adult students are a product of that type of educational background.

Johnston, et al. (1998) list ten factors that contribute to math anxiety:

- dislike of school,
- fear of a particular teacher,
- uncomfortable learning methods,
- pressure to be “clever,”
- emphasis on product rather than process,
- myths about the importance of math,
- gaps in schooling,
- definitions of masculinity / femininity,
- lack of math use since leaving school, and
- introduction of calculators.

Do your students suffer from math anxiety? The answer is usually, “Yes, without exception.” In most classes, that answer would be affirmed if you polled the students. Will it help to introduce the topic and lead a discussion on math anxiety? More
often than not, this is a good use of class time. The first step in overcoming any phobia (dare we call it “math phobia”) is facing up to it, defining its effects on performance, and determining its causes. Arem (1993) begins the preface to her self-help workbook, *Conquering Math Anxiety*, by telling about a student who would run from the math classroom and vomit uncontrollably. That student reported dreaming that numbers were chasing her, trying to hurt her.

**Dealing with Math Anxiety**

When the author taught math during a previous career, she would ask students to draw their “math monster.” This activity not only helped students analyze their fear of math, but it provided an opportunity to show students a possible reason for previous math failures. It gave them a way to redirect their math learning by explaining that freehand drawing is an activity which is primarily governed by the right side of the brain. Since math computations are a left-brain activity, students can be advised that many of them were right-brained dominated students being taught by left-brain dominant math teachers. Since numeracy involves many visualization and communication skills that are “right-brain” activities, students can be advised that learning math from a more right-brain approach helps the left side of the brain develop needed
reasoning and computational skills. Stated another way, this explanation gives students a rationale for past failures and hope for learning from a new approach to math.

To initiate a discussion of math anxiety, ask students if they exhibit one or more of the following symptoms:

- **Going Blank** – At the mention of math, suddenly you cannot reason or remember anything, as though a tall wall has been built between the world and your brain.
- **Tension** – Your body tightens up, your neck gets stiff, your hands shake, and/or your stomach gets queasy.
- **Paranoia** – You think everyone can figure this out but you, and they know it.
- **Tuning Out** – You start thinking about what you are going to have for supper, or you wonder how the coffee stain got on your sleeve.
- **Guilt** – You feel that you have been found out. The illusion that you are a functioning adult has been breeched, and the little math that you thought you knew is a fraud.
- **Panic** – Your pulse races, and you perspire. Disaster looms, and you will be destroyed.
- **Avoidance** – When math enters the scene, you remember that phone call you have to make or a colleague who is really good at this sort of thing who would love to do it for you.

Students who suffer from severe math anxiety may also feel threatened by computers or calculators. Hence the statement, “We can do this on the calculator,” may be as frightening to some students as it is reassuring to others. Students need to learn to use calculators, but the instructor must be careful not to allow technophobia to aggravate math anxiety.

Likewise severely affected students may be threatened by topics such as measurements. Even calculating change may elicit feelings of insecurity. For example, try to get a cashier to complete a
transaction if the cash register is not working; they panic at having to actually count the amount of change due the customer. Students who overcome math insecurities will probably succeed; those who do not have little chance of becoming good at math.

**Instructor Goals**

The goal of the Adult Basic Skills math instructor is to help students see that it is possible, rewarding, and even enjoyable to be able to use math in real life. Nothing is achieved if students memorize steps and types of problems to pass the test and therefore, "carry" little math with them. What little they remember, they cannot apply in the real world. They leave the classroom with the same negative attitude with which they entered, if not worse, by continuing to think "math is a waste of time because it isn't used in real life." To help students break this cycle and learn the skills needed for success on mathematics tests and in real life, instructors must:

- address self-doubt and math anxiety,
- teach critical thinking skills,
- include a variety of teaching strategies,
- use real-life materials, and
- make math interactive with students.

Educators have used various techniques to address math anxiety. Effective remedies invariably involve student discussion of their attitudes toward math, followed by the instructor emphasizing that previous failures do not mean a lack of math ability. Instructors essentially must help students change their thought processes. Previously we mentioned the possibility of discussing left-brain versus right-brain skills. Making students aware that learning styles differ enhances the approach. Be sure students understand that failure to excel in an environment created...
by a particular teaching style may reflect a mismatch of teaching and learning styles rather than a lack of ability.

Two vital steps for addressing math anxiety problems are an admission that one experiences those problems and the recognition that others share those problems. Students with math anxiety may believe they cannot change, so testimonials from former sufferers of math anxiety can be extremely helpful. The most effective testimonials are from peers; look for ways and opportunities to let students read, or better yet, hear, how others who were recently in their shoes conquered math anxiety.

Addressing self-doubt is important, particularly in learning mathematics. Many adult students do not feel confident, competent, or comfortable with math. Math anxiety is not an indicator of ability. Many students find that hard to accept. Some students remember when they liked math and were good at it. Students can write about the episode that caused their self-doubt. Writing can help put things into perspective.

As students regain confidence in their ability, their math anxiety tends to drift away. Confidence, however, does not increase unless students experience success in math. Students need to see math as applicable and vital to everyday life. Confidence builds competence; competence builds confidence.

When addressing math anxiety, the instructor’s belief in students’ abilities is critical. Success communicates, “Anyone can do math if they are given adequate instruction.” Supportive environments help students overcome their fear of math. Gaining self-confidence in math is dependent upon effective teaching.

Adult students need to perceive a change in performance if they are to change their perceptions of their own ability. Success, like competence, builds self-confidence.

Activating prior knowledge helps give meaning to new concepts which are an expansion of previous knowledge. Adult
students possess life experiences that allow them to take a pragmatic approach to learning. Experience and practice increases the ability to make connections. Adult learners readily seek connections between background experience and new concepts when they are taught to do so. Learning environment, intensity of learning, and relevance put new concepts into long-term memory.

*Numbers Talk,* a description of “Best Practices in Ontario LBS,” notes that instructors can “do much to alleviate math stress” (Glass, 2001). The author lists several items gleaned from student feedback including:

- Use review materials such as “self-tests” to build confidence.
- Give small tests to ease anxiety about bigger tests.
- Give un-timed tests; allow retakes.
- Encourage estimation as a tool to solve problems and check the feasibility of answers.
- Set the learner up for success; emphasize specifically what the learner has done correctly.
- Be patient.
- Instructors’ attitudes affect learners.
- Let the learner see the fallibility of the instructor to learn that no one is perfect.
- Encourage learners to talk about math anxieties and insecurities.
- Use deep breathing, lots of laughter, and breaks.
- Bring an enthusiastic, “Math is fun and useful” approach to the classroom.

Curtain-Phillips points out that math is often associated with tasks of pain and frustration (2004). Examples include paying bills, balancing checkbooks, and completing income tax forms. The use of problems that deal with more pleasurable activities such as
gardening, home repair, hobbies, sports, and vacations is a good approach to alleviating math anxiety.

Specific feedback indicates level of performance. Immediate feedback is essential for correcting conceptual errors. The results reinforce new learning.

Summary

Many Adult Basic Skills students have had negative math experiences. Previous schooling often associated intelligence with quick recall of facts. Testing and classrooms created a cycle of failure. Adult students may not have been taught to use prior knowledge as a base for new learning or to make applications of new knowledge to everyday life. Give students time to adjust to new learning techniques as their knowledge base and everyday applications are used to inspire interest and motivate learning.

Becoming familiar with available support services is another way instructors can help struggling math students. Students can hardly be expected to learn when their lives are in shambles. Directing them to support services is helpful. In 2003, the National Center for the Study of Adult Learning and Literacy published a research brief that identified several problems that are prevalent in Adult Basic Education. Ahlstrom stated:

Finally, many teachers do not play the role in the broader field of ABE (e.g., advocating for students’ needs, providing professional development to other teachers), either because they are unaware of opportunities or they are not inclined, prepared, supported, or even expected to participate outside of their program. (p. 3)
What you have to make them see—more than anything—is the future—which is mathematics.

Bill Cosby

Dianne B. Barber
Introduction

The number of younger students, ages 16 to 22, in Adult Basic Skills classes has increased in recent years. Many mature adults, ages 55 and older, are also returning to school. These two groups, combined with the "typical" adult students, create a trichotomy in background experiences, goals, and interests. Should all these different students fall under the classification "Adult Learners?" What do the experts say?

The experts are divided in their opinions partly because there is so much controversy over the definition of the term “adult learner.” The most widely accepted definition comes from publications of the National Commission of Higher Education where "adult learner" is defined as an individual whose major role in life is something other than full-time student. This definition certainly fits the majority of students in Adult Basic Skills classes. Most students have other roles in life and do not attend school full time. Does this mean that the Adult Basic Skills students all learn the same way? Probably not! Teaching in the Adult Basic Skills classroom would be much easier if all the students fit the mold of the adult learner and met the descriptive characteristics. Alas, that is not the case.
Some educators make distinctions among "younger learners," "adult learners," and "older learners." Making that distinction sets the stage for approaching the Adult Basic Skills classroom with separate teaching plans for each, however instructors need to develop an overall plan to accommodate all students.

Although these three student groups share common characteristics, they often approach learning differently. The next three sections explore characteristics of younger learners, adult learners, and older learners. The last section relates those characteristics and the differences among age groups to the learning of mathematics. First, however, a note of caution is in order. The characteristics, learning styles, and teaching strategies presented in this chapter are generalizations. Within each group there are exceptions. It is often helpful to plan teaching strategies that integrate differences among these groups. Meeting the needs of every student requires adjusting and varying teaching styles and strategies.

Younger learners are future-oriented, expect learning to be fun and stimulating, and need positive reinforcement.
Younger Learners

Younger learners may or may not exhibit immaturity. Obviously, those closer to age 16 are more likely to act immaturesly than those who are 20 or older. Immature behavior may include pouting, displaying anger, or acting up when things go awry. However, immaturity more often is expressed as irresponsibility; the irresponsible learner is more likely to be absent from class and less likely to complete out-of-class assignments. Younger learners sometimes show a very casual, unconcerned attitude. Other common characteristics of younger learners are explained below.

Younger learners are subject-oriented. Younger learners often are motivated by a desire to be successful, regardless of how courses relate to their personal goals. Younger learners accept sequential topics unless they doubt that the instructor knows the material or knows what they need to learn.

Younger learners are future-oriented. Younger students often accept mandatory education; yet resent the educational environment. They may not have realistic plans for achieving their goals, but are less likely to question that education will some day "pay off."

Younger learners are dependent on adults for direction. Younger learners are less likely to try to find solutions because they usually depend on older adults. Unless they find an Internet website that offers an explanation, they routinely expect instructors to provide course guidance. Unfortunately, they also expect instructors to make learning easy by presenting paced, step-by-step lessons. Direction in math is likely to be met with skepticism.

Younger learners accept new information. When you tell younger learners that the sum of the angles of a triangle is 180 degrees or the steps in the multiplication of fractions, they are more likely to accept that information without proof. They trust instructors’ knowledge. They also are more likely to accept incorrect solutions and conclusions, even when they are obviously illogical. Hence, they are less likely to correct work even when results are ridiculous.

Younger learners expect learning to be fun. Expended effort often relates to the degree of fun rather than how many
practical applications are shown. Generations who grew up with the Internet and television shows like *Mr. Wizard* expect clear, understandable instruction that makes learning fun and easy. Unfortunately, learning requires effort. Often younger students in Adult Basic Skills feel that few things in life are worth effort. Instructors must find innovative and fun ways to teach math.

**Younger students expect to be stimulated.** This is not surprising considering the variety of stimulating activities available. They are accustomed to being entertained and few things are as "awful" as being bored. They do not like to spend time on one task but respond to projects in which they can quickly demonstrate abilities and success. The worst option is work that is seen as both boring and irrelevant.

“Cutting edge” information grabs the attention of younger students. They already have access to much information, and most have learned how to seek it. When the class material is the same "old" stuff they heard before, they will probably react to it in the same "old" way they did when they failed to learn it the first time.

**Younger learners need positive reinforcement.** Many younger learners in Adult Basic Skills have little confidence in their ability to succeed in an educational environment. They may suffer psychological barriers because of previous difficulties in math. Many older learners have had time to experience success in other areas while younger learners may believe they have rarely been successful at anything. These students come with a subconscious expectation of failure. They simply do not know how to succeed.

An unclear future and no experience in planning contribute to dependence on others for learning. Younger students require guidance in learning to accept responsibility for their learning.
Adult Learners

Adults need to have a reason for learning. “Adult learners can’t be threatened, coerced, or tricked into learning something new. Birch rods and gold stars have minimum impact” (Zemke & Zemke, 1981, p. 2). Adults are not easily swayed by vague predictions of undefined future uses. Show practical, current mathematical applications to motivate adult learners. “Adults expect learner-centered settings where they can set their own goals and organize their own learning around their present life needs” (Donaldson, Flannery, & Ross-Gordon, 1993, p. 148).

The need to see practical applications is not the only way adult learners differ from younger learners. Additional adult learner characteristics are detailed below.

**Adult learners have a reason for enrolling.** Adults engage in learning for a variety of reasons—job advancement, pleasure, love of learning, etc. It is equally true that for most adults learning is not its own reward. “Adults who are motivated to seek out a learning experience do so primarily because they have a use for the knowledge or skill being sought. Learning is a means to an end, not an end in itself” (Zemke & Zemke, 1981, p. 1). Since adults need to have a reason for learning, they have a reason for being in class.
Find out what it is. Seek examples of direct workplace applications. Career goals are often powerful motivators for adult learners.

Sometimes the Adult Basic Skills student becomes frustrated by their lack of opportunities. When this is the case, choose mathematical applications from many careers thus expanding horizons and creating opportunities for the future.

**Adult learners’ pursuit of additional education is a major decision.** The decision to return to school is a major decision for adult learners. Returning to school involves adjustments. It is important to adult learners that they reap benefits from their investment of time, energy, and personal sacrifices.

**Adult learners are usually homemakers.** They are less likely to live in a home provided by someone else. Most adult learners maintain a household, whether it is an apartment with or without roommates or a house with or without a family. Almost all adult learners must budget and make purchases to support their daily lives. Homemaking is accompanied by a variety of other activities, including home repairs, home building, hobbies, and leisure activities. Learn about students’ home and family situations to find practical applications. Then teach to those needs and interests.

**Adult learners see the Adult Basic Skills program as an avenue for increasing self-esteem.** Very few students enter Adult Basic Skills programs for the sole purpose of improving self-esteem; however, “Increasing or maintaining one’s sense of self-esteem and pleasure are strong secondary motivators for engaging in learning experiences” (Zemke & Zemke, 1981, p. 1).

**Adult learners take errors personally.** Adults are easily embarrassed by what they perceive as inadequacies. They are self-conscious about not having learned math, and their insecurity makes them very cautious. When adult learners show anguish over mistakes, create situations that diminish anguish. Correct errors tactfully. Use sincere praise. Provide guidance to help learners discover their errors and make improvements. Remember that building self-esteem is a long-term project, but destroying it is instantaneous.

**Adult learners like to be in control.** Although adult learners are dependent on instructors for guidance, they like to develop their own projects and have control over approaches and timelines.
Although adult learners usually indicate a preference for self-directed rather than group projects, they can excel at collaborative learning. Adults “see themselves as proactive, initiating individuals engaged in a continuous re-creation of their personal relationships, work worlds, and social circumstances rather than as reactive individuals, buffeted by uncontrollable forces of circumstance” (Brookfield, 1986, p. 19). “Adults prefer self-directed and self-designed learning projects 7 to 1 over group-learning experiences led by professionals. However, self-direction does not mean isolation. In fact, studies of self-directed projects involve an average of 10 other people as resources, guides, encouragers, and the like” (Zemke & Zemke, 1981, p. 3).

**Efficiency of learning is important to adult learners.** Most adult learners have many responsibilities and thus have no tolerance for wasting time. They want to get right to the point, do what needs to be done, and go back to their own lives. They expect immediate applications for each skill. Failure to show immediate application may lead students to question the instructor’s common sense. When they start saying things like, ”The instructor has a lot of book learning but he/she doesn’t understand the real world,” the instructor begins to experience problems maintaining trust, interest, attention, and, even, attendance.

**Adult learners may become impatient.** Adult learners often try to meet the demands of job, home, and family while adding school. Few students are in a position to ignore other aspects of their lives to focus on schoolwork. Instead, they steal a few moments here and there to prepare. Stress and lack of sleep are common. The opportunity to sleep late or take a few days off rarely exists, hence, adult learners may become irritable and impatient. They may have trouble focusing. Plan active classes that maintain student interest even when they are tired or in a bad mood.

**Adult learners have valuable life experiences.** Many adult learners are in a position to make significant contributions to class discussions because they have had unique and interesting experiences. They gain a sense of self-worth when called upon to relate those experiences for the good of the class. Building on life experiences leads to efficient and effective learning. When class members relate practical math application other learners quickly
accept its relevance to the real world. “Not only do adult learners have experiences that can be used as a foundation for learning new things but … readiness to learn frequently stems from life tasks and problems. The particular life situations and perspectives that adults bring to the classroom can provide a rich reservoir for learning” (Imel, 1998, p. 2).

**Adult learners need to activate prior knowledge.** “New knowledge has to be integrated with previous knowledge; that means active learner participation. Since only the learners can tell us how the new fits or fails to fit with the old, we have to ask them” (Zemke & Zemke, 1981, p. 5). Prior knowledge lays the foundation for developing self-confidence and learning. “Information that has little ‘conceptual overlap’ with what is already known is acquired slowly” (Zemke & Zemke, 1981, p. 3). When new information conflicts with prior knowledge acceptance occurs more slowly.

New concepts may extend previous knowledge through experience and practice. Lessons can teach adult learners to connect background experience and new concepts.

**Adult learners crave positive feedback.** They are insecure, impatient, and need to do well. When those feelings are combined, adult learners are very anxious to know how well they are doing. It is important that you return written assignments promptly, and explain to students how they are evaluated. Give suggestions for improvement and make understandable corrections.

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**Older Learners**

Some older learners simply want a high school diploma. Students who are fifty-five or older are less likely to be motivated by their job or career. One way to define "older learner" is to base the distinction on diploma goals versus career goals. This difference in goals produces a distinct group of learner characteristics.

Hiemstra (1993) defines older students as age fifty-five and older. However, it is hard to define an age at which there is a major change in learner characteristics. Obviously, goals and characteristics of sixty-year olds may parallel those of "traditional"
adult learners more than those of many fifty-year olds; age becomes an arbitrary distinction. Older learners may have a unique set of problems and characteristics such as those identified below.

**Older learners may have age-related health problems.**
Instructors should be sensitive to potential health problems of all students, but older students are more likely to have geriatric-related problems, such as digestion and bladder control. Students may be reluctant to request a break; therefore, plan frequent breaks or arrange instructional activities so students feel comfortable leaving the room as needed.

Mobility or agility may make participation in certain activities painful or undesirable. Be especially careful of activities that involve getting down on the floor. “The learning environment must be physically and psychologically comfortable. Adults report that long lectures, periods of interminable sitting and the absence of practice opportunities are high on the irritation scale” (Zemke & Zemke, 1981, p. 5). Uncomfortable students are not likely to be good learners.

**Older learners may be easily embarrassed.** Use non-offensive humor in the classroom. Strive to create an atmosphere that respects individuals. Adults’ emotional states are inextricably tied up in their ability to learn. Adults must be emotionally comfortable with the learning situation (Draves, 1984). J. Roby Kidd in *How Adults Learn* states, “Feelings are not just aids or inhibitors to learning; the goals of learning and of emotional development are parallel and sometimes identical and can probably be most conveniently stated as self-realization and self-mastery” (1973, p. 95).

**Older learners may be involved in reading or travel.** Many older students have time to read, travel, and keep abreast of current events. One effective way of showing practical applications of course content is to relate it to travel and current issues, such as the difference in currency, cost of goods, global warming, cloning, or
the war on terrorism. These are valuable resources for discussions and activities.

**Older learners have lived history.** Many instructors do not realize that younger learners were not alive during Vietnam, when the TV remote was invented, when there was no Internet, etc. By the same token, older adults have experienced these events. Older students can discuss where they were when Neal Armstrong walked on the moon or when John F. Kennedy was assassinated. Learners who relate personally to historical events, and even learned arithmetic skills without a calculator, can be valuable classroom resources.

**Older learners may experience difficulty with memorization.** The ability to learn new things often fades with age. Older learners may depend very heavily on experience, practice, and understanding to make connections with and learn new concepts because memorization skills decline with aging (Nelson & Albert, 2004).

**Older learners may like to talk.** Many older students enjoy companionship and enjoy talking. Some tend to get carried away with irrelevant tales, so tactful guidance of class discussion becomes very important. The instructor enhances self-esteem, provides motivation, and inspires effort while giving valuable classroom time for discussion. Balance the presentation of new material, debate and discussion, sharing of relevant experiences, and the clock.

Older learners may enroll in classes to prepare for, or deal with, a life-changing event, such as the loss of a job or the loss of a spouse, whether due to death or divorce. Moving to a new location, retiring from a job, or experiencing the "empty nest" syndrome can inspire a decision to pursue additional education.

**Different Yet Alike**

Instructors must understand what motivates students to learn. Directors of basic skills programs report that a common goal of students returning to basic skills programs is to earn their GED or Adult High School Diploma. Why do students want additional
education? Will it make them better parents or better employees? How will it empower them or help them to take control of their lives? To provide situations that stimulate motivation, instructors must understand what originally motivated students to enroll. Understanding student motivation allows instructors to tailor instruction and enhance and draw upon that motivation.

Students should recognize what motivates them to learn. In Stein's (1995) report, adults gave reasons for wanting to improve their literacy. They saw it as a tool to become more informed individuals and to take control of their lives. A powerful motivation is to become empowered to make major decisions in life as parents, citizens, employees, and members of communities.

In a different study on adult motivation by Beder and Valentine (1990), students gave a variety of reasons for returning to school, such as:

- self-improvement,
- provide family role-modeling,
- social interaction or entertainment,
- increase literacy skills,
- increase involvement in community or church activities,
- improve employment potential,
- prove they can take control of their lives,
- increase earning potential, and
- complete high school or enter college.

Attaining a high level of literacy and numeracy skills allows students to develop power over their own lives and personal situations, improving the quality of their lives. Job advancement and career opportunities are not always the primary motivator. As service industries replace manufacturing industries, positions continue to exist in the service sector. Improving literacy and numeracy skills does not guarantee a better paying or more interesting job nor does it ensure job success or advancement. Becoming aware of all factors that motivate students enables instructors to better address students' needs.
Regardless of age, learners hold high expectations for their instructors. Imel (1998) describes the major expectations for instructors in *Teaching Adults: Is it Different?* They are described below.

**Students expect instructors to be knowledgeable.** Students want to learn from an instructor who knows the content. It is equally important that students have faith in what the instructor tells them. They want the instructor to be honest about his or her knowledge, so they can believe in what they are being taught. Admitting to not knowing something does not destroy the instructor’s image unless it is too frequent. Admitting to making an occasional mistake will not decrease students’ respect. However, defending errors, refusing to admit mistakes, and bluffing quickly destroys instructor effectiveness.

**Students expect instructors to show concern.** Students need to know the instructor has faith in their ability and cares if they learn. It is usually more important for students to believe the instructor wants them to learn out of concern for their welfare than because knowledge is vital to their future success. Of course, students should believe both. We all respond best when people care about us. Students are no exception. Believing the instructor cares is a vital component of changing one’s approach to learning.

**Students expect the instructor to present material clearly.** Organization and preparation for teaching are vital contributors to student success. Even simple concepts can be difficult when the instructor shows confusion or makes repeated errors.

**Students expect the instructor to be enthusiastic.** Enthusiasm for learning math is vital to encourage students to accept the relevance of material. Tired, bored, and/or indifferent instructors cannot motivate learning or convince students the material is important.

**Students expect the instructor to respect their cultural and ethnic heritage.** The Adult Basic Skills classroom is a group of students who may be culturally and ethnically diverse, differing in age. Weinstein-Shr (1996) recommends that instructors be sensitive to this diversity and make learning relevant by using teaching methods and activities that address the ethnic, cultural, and age diversity of adult students.
Engaging in participatory adult learning begins by respecting learners’ culture, their knowledge, and their experiences (Auerbach, 1992). According to Imel:

A growing number of adult literacy educators are advocating for understanding learners both as individuals and as members of their particular communities or groups (Nonesuch, 1996; Sissel, 1996) and tailoring instruction to address those particular contexts. Nonesuch (1996) describes how the experiences of women can be used effectively in developing curriculum. (1998, p. 3)

Tailoring math to diverse populations requires problems that respect cultures. Historical or cultural references may inspire interest and make new information easier for students to comprehend and assimilate. Naturally, instructors developing adult-centered activities must remember to consider differences in individual learning styles, abilities, experiences, and backgrounds.
Learning Styles

J. Pat Knight

Tell me and I'll forget.
Show me and I may not remember.
Involve me and I'll understand.

Native American Saying
How Do People Learn?

Instructors of mathematics can better introduce adult students to the fascinating aspects of mathematics through understanding how people learn, by knowing how to teach to individual needs, and by building an extensive repertoire of student-related problems and associated concepts.

Thinking back to our school days we quickly remember exciting classes and dynamic instructors who filled their classes with exciting approaches, who attended to how students learned best, who incorporated intriguing and creative ideas, and who connected content and real-life situations. Those instructors were enthusiastic and insightful. The enthusiasm was contagious and remembered.

Sadly, adults seldom remember mathematics classes as places of enthusiasm and creativity or as places where they experienced a “learning high.” They feel obligated to express their lack of enthusiasm about mathematics and often respond with, “You know, I have always been terrible in math.” Adults profess their lack of interest in math. Instructors cringe at the number of students who fail mathematics. They shake their heads. “What a loss!”

What causes this failure, this lack of enthusiasm; this apathetic sense of being? It may be that mathematics instructors do not demonstrate beauty and wonder in mathematics. They do not make achievement a dynamic and worthwhile process. Maybe achievement is not about books and worksheets, mandated philosophy or perceived IQ. Maybe the process of mathematics achievement stems from resourceful instructors who understand individual learning styles, who relate relevant topics to students, and who are genuinely enthusiastic about teaching and learning the subject. The National Research Council stated, “…the quality of instruction is a function of teachers’ knowledge and use of mathematical content, teachers’ attention to and handling of students, and students’ engagement in and use of mathematical tasks” (Bradford, Brown & Cocking, 2001, p. 315).

During the late 19th century the mental disciple theory of learning greatly influenced mathematics teachers. The theory
projected the mind as a muscle and benefited from exercise just as other muscles. Early in the 20th century Edward Thorndike’s Stimulus-Response theory replaced the mental disciple theory. This theory was based on the belief that learning occurs when a connection is established between a stimulus and an appropriate response. Drill was heavily emphasized to establish a strong connection between number patterns.

In the mid-twentieth century researchers such as Jean Piaget, Jerome Bruner, and Robert Gagne emphasized the development of understanding as fundamental to learning mathematics. The meaning theory is predicated on the concept that students understand if learning is to be permanent. The theory supports the use of manipulatives to establish the meaning of new concepts.

Piaget emphasized that the process of learning as one of continual assimilation and accommodation (Atherton, 2003 and Wadsworth, 1984). That is, a student confronted with new experiences actively makes sense of the new idea in relation to old experiences and ideas. Basically Piaget’s theory of learning is known as “constructivism.” Learners construct meaning rather than passively receive information.

Skemp (1998) separates learning into two stages. Level one suggests that the manipulation of objects provides students with a basis for further learning and the internalization of ideas. These manipulative experiences form the background for the second level and later learning at the abstract level.

Gagne (1985) believed that learning improved when participants mastered tasks in a sequential manner.

Cognitive theories of learning have made a significant contribution to knowledge about learning. The computer can be used as a metaphor for describing how learning takes place according to cognitive, or information processing, theories. Short-term memory stores new information that is received, but it has a limited capacity and a limited duration. Long-term memory is a complex web, or schema, of concepts, ideas, and relationships that represent important existing knowledge. For learning to occur, new ideas and experiences must be transferred from short-term memory.
into long-term memory. These ideas can then be retrieved and used repeatedly if they are stored with many meaningful connections. (Kennedy & Tipps, 1991, p. 27)

In planning effective and inviting lessons instructors must be familiar with learning theories and assume several important rules.

**Identify and evaluate students’ learning needs.** The instructor determines and prioritizes the most important concepts to be learned. Included are student goals, development of problem solving and metacognition skills, knowledge of student learning styles, possession of varied teaching strategies, the development of creativity, and expanding mathematical confidence.

**Determine learning styles and teaching strategies.** Instructors are most effective when they align their teaching styles and methods to student needs, learning styles, interests and concept relevancy. This complicated task reflects student uniqueness. Backgrounds, interests, abilities and learning styles may be similar, but never the same. An additional complication is that students not only differ from one another, but their differences vary from day to day. What appeals to a student today may not appeal tomorrow.

**Organize concepts hierarchically.** The understanding of facts, concepts, and procedures requires prerequisite knowledge. Students must understand previously presented concepts and strategies in new ways and combinations. Understanding must go beyond mere exposure to previous material; it must include internalization and adoption.

**Develop activities that stimulate the development of proposed concepts.** Students must discover the importance of new concepts. They should receive only as much structure or modality (methodology) as they need or can internalize.

Without question each student comes to class with a different mode of confronting learning tasks and problem solving. What can instructors do to respond to the variety of differences?

“One approach is to tailor all instruction to the specific needs and predispositions of individual students“ (Witkin, Moore, Goodenough & Cox, 1977). Field-independent students, for
example, are encouraged to work on independent projects, while field-dependent students work in small groups. The opposite position works against students’ style by (Shipman & Shipman, 1985) striving for balance and attempting to direct impulsive students into reflecting and vice versa.

The attention to learning styles has definite merit; but how realistic is the concept with reference to classes of 10-20 students? It appears that the concept of learning styles, though it may be difficult to implement, has at least two very important applications to teaching.

First, instructors need to vary instruction and practice. It is evident that instructors who vary strategies are more effective than those who teach the same way every day. The importance of instructional variety is supported by research (Rosenshine & Stevens, 1986).

The second concept suggests that attention to learning styles reminds instructors that students are different, and they must become more sensitive to student behavior.

“People are different, and it is good practice to recognize and accommodate individual differences. It is also good practice to present information in a variety of ways through more than one modality” (Eggen & Kauchak, 1996).

People are different, and it is good practice to recognize and accommodate individual differences.
Learning modalities refers to the sensory portal (input avenue) by which a student receives information (modal preference) or the actual way a student learns best. Some students learn best by using the visual modality, others prefer to gain instruction through talking and listening to others (auditory modality), still others may prefer to gain information through doing and being physically involved (kinesthetic modality), while others prefer to learn by touching objects (tactile modality).

Usually modality preferences can be determined by observing the student, but several check lists provide a means of evaluation. It should be noted that a student’s modality preference is not always a student’s modality strength. It should also be noted that a student’s primary modality strength can be mixed and altered as a result of experience and intellect. It is evident that engaging more than one of the students’ modality preferences can contribute to greater achievement.

Instruction utilizing only one modality restricts students who learn more easily using a different sense. For example, student achievement is greatly restricted by an instructor who prefers to lecture or uses discussion continuously when the student has a strong preference for tactile, kinesthetic, or visual modality.

Dunn (1995) presents several learning style traits that significantly discriminate between poorer achievers and outstanding performance. Dunn reports that a majority of the low achieving students need:

- frequent opportunities for mobility;
- choices;
- a variety of instructional resources, environments, and sociological groupings rather than routines and patterns;
- low illumination, because bright light contributes to loss of attention; and
- seating in an informal setting rather than a formal one with hard, uncomfortable chairs.

Integrating learning modalities provides the greatest success.
Related to learning modality is learning style or cognitive style. Individuals have a preferred learning style for processing and organizing information and for responding to environmental stimuli. Learning styles are the cognitive, affective, and psychological ways learners perceive, interact with, and respond to the learning environment (Schmeck, 1998). Students with different learning styles understand and try to solve problems in different, and possibly, relatively static ways.

Students vary not only in their skills and preferences for attaining knowledge, but in mentally processing information. Processing reflects learning style.

There are probably as many learning styles as individuals. It must be noted that learning styles do not indicate intelligence, but rather how a person learns. David Kolb suggests two major differences in how people learn, “how they perceive situations and how they process information” (1985, p. 89).

On the basis of perceiving and processing, Bernice McCarthy (1990) describes four major learning styles.

1. **Imaginative learners** perceive information concretely and process it reflectively. They learn best by listening to and sharing with others to integrate ideas with past experiences. The traditional classroom setting of lecture and seatwork creates difficulty for imaginative learners.

2. **Analytic learners** perceive information abstractly and also process it reflectively. This type of learner prefers thinking in a sequential manner, needs details, and values the opinions of “experts.” The analytic learner performs well in traditional classrooms.

3. **Common-sense learners** perceive information abstractly and process it by relating to its value. This type of learner needs much hands-on activity. They need to see immediate use for new information.

4. **Dynamic learners** perceive information concretely and process it according to use. This type of learner is a risk taker and becomes frustrated with tedious situations. (p. 89)
The Piaget Theory of learning suggests that as students learn they “move” or are guided from concrete hands-on learning experiences to the abstract formulations of concepts and their applications. Bernice McCarthy (1990) has modified this learning cycle to include three phases:

1. **exploring, hands-on phase** where students are encouraged to explore ideas that facilitate their own questions and perceived answers;
2. **concept developmental phase** where the instructor guides students to invent concepts which help them answer their questions and reorganize their ideas; and
3. **concept application phase** where students try out their newly conceived ideas by applying them to relevant and meaningful situations.

Through effective teaching and learning, students are encouraged to sense, feel, experience, watch, and then reflect, think and develop theories. Ultimately, they evaluate what they experience and attempt to apply the information to a new experience. An additional concept in the area of learning differences is the approach identified as Howard Gardner’s “Theory of Multiple Intelligences” (1999). Gardner refers to the theories as learning capacities. The following seven intelligences are traditionally accepted:

1. **verbal-linguistic**: sensitivity to the meaning and order of words;
2. **logical-mathematical**: ability to handle chains of reasoning and to recognize patterns and orders;
3. **visual-spatial**: ability to manipulate the nature of space, such as through architecture, mime, or sculpture;
4. **musical-rhythmic**: sensitivity to pitch, melody, rhythm, and tone;
5. **bodily-kinesthetic**: ability to use the body skillfully and to handle objects with dexterity;
6. interpersonal: ability to understand people and relationships; and

7. intra-personal: sensitivity to one’s emotional life as a means to understand oneself and others.

Two additional capacities are currently associated with Gardner:

8. naturalist: ability to draw on the natural environment to solve problems or fashion products and

9. spiritual: sensitivity to the supernatural.

The theory of Multiple Intelligences has very strong implications for adult learning and development. Many adults find themselves in situations that do not make optimum use of their individual intelligences. For example, a bodily-kinesthetic individual may be assigned to a desk task when that individual might be more conducive to learning in an informal environment that allows movement.

The theory of Multiple Intelligence suggests several unique strategies for facilitating effective learning.

Students will decide which pathways are of interest and appear to be their most effective learning capacities. For example: if one is teaching or learning about the law of supply and demand in economics, that individual might read about it (linguistic), study mathematical formulas that express it (logical-mathematical), examine a graphic chart that illustrates the principle (spatial), observe the law in the natural world (naturalist) or in the human world of commerce (interpersonal); examine the law in terms of their own body, i.e., when the body is supplied with sufficient food, the hunger demand goes down; when there is very little supply, the demand for food goes up and the individual becomes hungry (body-kinesthetic and intra-personal); and/or write a song or find an existing song, such
as Dylan’s ‘Too Much of Nothing,’ that demonstrates the law. (Armstrong, 1994)

**Implications for Mathematics**

In the previous description of how students learn, learning situations are not portrayed as the presentation in clear, precise explanations, or procedures to be practiced by students. Instead knowledge/learning is constructed by each student as he/she engages in various mental activities, aligning his/her specific learning competencies (skills) to the learning situation, building relationships between and among mathematics ideas through reflection, relating the new situations to prior knowledge, and articulating the explored mathematics concepts.

Only when instructors begin to understand the aspects, skills, and stages of mathematical learning will they be able to help students receive instruction most appropriate to their individual learning styles.

The instructor of mathematics should pose tasks that are based on the following:

- sound and significant mathematical concepts;
- knowledge of students’ understandings, interests, and experiences;
- knowledge of the diverse ways students learn mathematics; and that
- knowledge that engages students’ intellect;
- developing students’ mathematical understandings and skills;
- stimulating students to make connections and develop a coherent framework for mathematical ideas;
- problem formulation, problem solving, and mathematical reasoning;
- communication about mathematics;
- mathematics as ongoing human activity;
➤ sensitivity to students’ diverse background experiences and dispositions; and
➤ development of students’ dispositions to mathematics. (Blythe & Gardner, 1990, p. 35)

Quality mathematics instruction emerges from tasks an instructor provides and expects from students. The overriding purpose of this section is to provide instructional concepts that help students develop understanding of and make sense of mathematical precepts due to a match between teaching and learning styles.

Because individuals learn differently and instructors and adult learners have different personalities, it is inappropriate to recommend a single approach to teaching mathematics. Instructors must vary and adapt strategies to specific student needs.

The National Research Council (Bradford, Brown, & Cocking, 2001) and the National Council of Teachers of Mathematics (1980) have developed specific guidelines for instructors in designing mathematics instruction.

1. **Provide developmental instruction.** Instructors must attend to the cognitive growth of their adult students. Learning how adults think and the levels of their thinking is vital in the development of mathematics instruction.

2. **Engage adults in active learning.** The use of concrete and relevant examples is the cornerstone of successful mathematics instruction. The brain learns best and retains more when the organism is actively involved in exploring physical sites and materials and asking questions to which it actually craves answers. Merely passive experiences tend to attenuate and have little lasting impact. (Gardner, 1999, p. 82)

3. **Develop adults’ mathematical power.** Adults gain mathematical power when they understand the concepts and procedures they have constructed.
4. **Provide opportunities for adults to construct and communicate mathematics.** When adults construct mathematics through their experiences and through interaction with instructors and colleagues they develop schemas that continue to serve them as they advance to higher mathematical concepts.

5. **Continually introduce new techniques.** Instructors should accept the role as change agent for mathematics instruction with adults.

As previously noted, both students and instructors have distinct needs and styles of operation in the teaching/learning process. Adults’ personal learning styles are unique to them. Style determines how and when adults develop mathematics concepts.

It is most important for the instructor of adults to understand that their personal teaching style affects how they teach. Beliefs, experiences, education, and expectations of adult learners cause the instructor to be a specific type of teacher.

When organizing for numeracy instruction, base instruction on sound principles of learning. Instructors of numeracy must reflect that each particular strategy is a function of itself and may be successful only under certain unique situations. Consequently, instructors of mathematics must continually try new and imaginative approaches to adult learning.

**Age and Learning Preferences**

As older adults increasingly participate, instructors are being forced to find ways to improve teaching strategies delivered to these individuals. However, very little is known about the learning styles of older adults.

A study utilizing D. A. Kolb’s (1985) Learning Style Inventory was enacted in an attempt to identify preferred learning styles of older adults. Types were fairly evenly distributed across accommodators who learn by feeling and doing, assimilators who learn by thinking and watching, and divergers who learn by feeling...
and watching. Few preferred the converger style that involves thinking and doing while learning.

No significant effects were determined between learning style preference and gender, age or educational level. Truluck and Bradley (1999) noted that:

1. more of the 55-65 age group preferred the accommodator learning style;
2. more of the 66-74 age group preferred the diverger learning style; and
3. the 75 and older age group seemed to prefer the assimilation style.

It appears that as age increases learners tend to become more reflective and observational in the learning environment. Data suggests that age may not be a factor in learning style preference. However, the typical twenty-something student seems to prefer direct hands-on learning situations, while older students prefer to learn by listening and reading. It appears that younger adults tend to be more active in their approach to learning, and older individuals tend to be more reflective and abstract.

Instructional quality and value of the learning environment directly relates to the quality of interpersonal relationships between the adult learner and the instructor.


**Student–Instructor Interaction**

The importance of informal student-instructor interaction has long been upheld. Numerous studies have found that the instructional quality and value of the learning environment directly relates to the quality of interpersonal relationships between the adult learner and the instructor. The more accessible the instructor is in sharing experiences, ideas and personal times outside the classroom, the more effective the instruction. The operative phrase is sharing personal time outside the classroom. The degree of accessibility of an instructor has a positive influence on the academic performance and overall instructional satisfaction of the adult learners (Thompson, 2001).

It appears that adult students benefit from a higher quality of informal interaction as well as the modern and affective approaches to teaching that encompass different learning styles and learning preferences.
Teaching the Content

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Just as houses are made of stones, so is mathematics made of facts; but a pile of stones is not a house and a collection of facts is not necessarily mathematics.

Henri Poincaré
Introduction

“At the end of the day, we are tired from working, she expects us to think.” This comment was reportedly made to a counselor about a math instructor at a community learning center in Massachusetts (Leonelli, 1999, p. 8). Would you want this comment to be made about you? Would you have it any other way?

When Esther Leonelli reported the above quote made by one of her students, she was describing how her approach to teaching math has changed in recent years. She now uses a set of teaching strategies that relies heavily on analyzing real world situations to develop problem-solving techniques. This approach replaces a heavy emphasis on number drill and practice that she reported using years ago.

What does the above quote say about learning math in Adult Basic Skills classrooms? It seems to describe the students that enter most classes, particularly evening classes. It points out why teaching Adult Basic Skills is especially challenging. It captures the challenge of teaching and learning math. Perhaps most significantly, it emphasizes that math can, and in fact must, be learned by thought and application to real world problems. Teaching and learning are active processes.

Make It Relevant

Whether they need additional skills to advance their careers or have specific learning goals, adults appreciate the value of an education. Having a group of interested and motivated students creates an opportunity to be seized and developed.

The instructor must quickly offer students a chance to build self-confidence through success. Without confidence in their ability, adults quickly succumb to the suspicion that they “just can’t succeed.” The instructor must facilitate immediate success and build self-confidence through a series of subsequent successes in math that obviously relate to the real world. There are several
instructional strategies which have been used effectively by experienced instructors. Holt (1995) lists techniques that involve beginning level learners as active participants. Although taken from techniques for teaching ESL, they are equally applicable to teaching math.

- Build on the learners’ experiences.
- Use learners as resources. Ask them to share knowledge and expertise with others in class.
- Sequence activities from less to more challenging.
- Encourage interaction by providing cooperative learning activities in which learners must negotiate with partners or group members.
- Include a variety of techniques to appeal to diverse learning styles.

Whether deciding what concepts to teach or how to teach them, the most important guideline is relevance of the math to the learner. Relevant math generates enthusiasm instead of boredom, interest instead of disdain, and success instead of failure.

Many learners feel learning math at work was most beneficial. Math learned on the job was directly applicable to them (Curry, Schmitt, & Waldron, 1996). Too many adult learners view classroom math as totally unrelated to the workplace. To pave the road to success, strive to make it impossible for students to say, “I’ll never use this” by using obviously relevant examples and problems.

Just as a structural foundation provides support for walls, etc., so number sense provides support for developing math skills.
Teach Numbers and Number Sense

There is a parallel between learning math and building a building. In both cases, one must start with a solid foundation. The foundation necessary for learning math consists of a basic understanding of sorting, classifying, ordering, counting and pattern recognition. Students who possess this foundation can proceed with the construction of a frame for their math learning; those who do not possess this foundation need to build or rebuild it.

Just as a structural foundation provides support for walls, etc., so number sense provides support for developing math skills. Students have gained number sense when numerical values create pictures in their minds. These “mind” pictures should be generated by a wide range of numbers stated in many forms, such as 17, 1.67, 2 1/3, 7/3, and 20%. When values are expressed in different forms, the students are comfortable sorting, ordering, and classifying.

“Number sense includes calculation skills with numbers as well as a sense of number and operation and an ability to appropriately use estimation, mental math, computation, calculators, or other tools” (Curry, Schmitt, & Waldron, 1996, p. 34). The Massachusetts ABE Math Standards state:

To be efficient workers or consumers in today’s world, adults must have a strongly developed understanding of arithmetic operations as well as procedural knowledge of computation and number facts. They must be able to perceive the idea of place value and be able to read, write, and represent whole numbers and numerical relationships in a wide variety of ways. Simple paper and pencil computation skills are not enough. Adults must be able to make decisions regarding the best method of computation (mental math, paper-and-pencil, calculator/ computer) to use for a particular situation. (Leonelli & Schwendeman, 1994, p. 38)

The ability to choose the most appropriate computation procedure has obvious value in a workplace setting, and is equally
as important when maintaining personal records or making daily decisions. A calculator is not necessary when determining the cost of an item at a 50% off sale or when deciding what time to leave home to arrive at a meeting on time, but it is a good computational aid when completing federal income tax forms or balancing a checkbook. Sometimes estimation is the only technique required; in many instances it provides valuable protection from major errors.

Teach Estimation

Number sense is essential for being able to make estimates of numerical values that result from a variety of mathematical operations. Practicing estimation skills solidifies and enhances one’s number sense.

Virtually everyone estimates throughout the course of daily life. Estimation often involves time, size, distance, number of items that will fit in a given space, quantity, and total cost. The first step in teaching and enhancing estimation skills is to get students to recognize how well they already use estimation on a daily basis.

With guidance, students can identify home and workplace situations when estimation provides a sufficiently accurate value, and is actually preferred because it is timelier or more efficient. Identifying situations where estimating is appropriate helps students to recognize estimation as a legitimate component of math.

The vast majority of math computations in the real world are word problems. Estimating a reasonable answer may help students choose appropriate computational procedures. However, the most
important value of estimation is to guard against errors that can result from incorrectly entering values into a calculator or multiplying instead of dividing. The author once weighed a textbook in front of a class to determine its weight in grams, then asked students to calculate the weight of the textbook in pounds. For obvious reasons, those students who obtained an answer of more than 100 pounds should have realized the answer could not be correct. When estimation is used as a check, it can help one avoid major errors.

Estimation is a critical life skill. Often a calculator is used to solve problems. Being off by a factor of 10 will certainly change an answer even if the digits are correct. Usually in life, we do the “number crunching” with a calculator; we check the reasonableness of the answer using estimation. If students are to learn estimation skills, they must be practiced.

Estimation is one place where the instructor helps students realize there is often more than one way to get the correct answer. Being freed from erroneous beliefs about only one correct way to solve a given math problem allows students to become thinkers rather than memorizers. Estimation can be improved with practice, while it provides an opportunity to invent one’s procedures. Many students find estimation to be more stimulating and enjoyable than memorizing and following rules and procedures.

Students should be encouraged to share how they use estimation in their jobs and their lives. Sharing stimulates other students to recognize and share how they use estimation. Estimation is probably the most used and most useful skill for adults. Adults use informal estimates in activities such as cooking, shopping, buying clothes, or estimating the time required for daily tasks. Good estimators use a variety of strategies and techniques for computational estimation (Leonelli & Schwendeman, 1994).

Life is seldom a multiple-choice exam, but in an educational setting many assessments are multiple choice. Even for those multiple-choice questions where the correct choice is not obvious with estimation, it will tell the student which choices are obviously incorrect.

Exploration, class discussion, and collaborative learning are excellent techniques for teaching estimation. Instructors may wish
to share some estimation tips, but should try to do so as a discussion participant rather than an authority.

Teach Geometry, Spatial Sense, and Measurement

Most adult students recognize a variety of geometric shapes, and many are quite good at estimating surface areas or volumes. A wealth of pragmatic experience is likely to include building projects, calculating areas for home decorating, sewing, quilting, or gardening. Generating discussion of such experiences can “trick” the student into verifying their knowledge and skills before they “freeze” upon hearing the word geometry.

Everyone estimates distances and nearly everyone has measured distances. Measurement by volumes is practiced in many aspects of daily life ranging from food preparation to auto maintenance. Many students have calculated areas so they would know how much paint, wallpaper, or fertilizer to purchase. “For many adult students, geometry is one math topic that immediately makes sense to them and gives them confidence in their ability to learn” (Curry, Schmitt, & Waldron, 1996, p. 37). “Because
measurement is used so often and in so many contexts, many learners have great confidence in their measurement skills” (p. 51).

Adult Basic Skills instructors must strive to solidify and enhance students’ understanding of how many things are routinely measured. In addition to lengths, areas, and volumes people measure time, temperature, height, weight, capacity, and angles. Geometry involves the use of measurement in practical, real-world applications.

The Adult Basic Skills classroom should be a place for practicing applications of mathematics to everyday life. The necessary materials for designing a learning environment to enhance teaching geometry, special sense, and measurement are all around us. A wealth of free or inexpensive materials can be used to illustrate geometrical concepts. An excellent source comes from the students. After all, students are in the best position to determine how they use, and need to use, mathematics.

By asking why students want to learn mathematics, the instructor gets teaching ideas. The instructor no longer has to be the source of all knowledge but can depend on learners to supply authentic materials to supplement standard materials. Why make up real-life contexts when the genuine article is at our fingertips? Use product labels, blueprints, lumber dimensions, or metric weights, cups, and gallons when teaching geometry, spatial sense, and measurement.

Give real-world meaning to math by basing problems on measurement or other data obtained by class members. The classroom should be stocked with manipulatives, such as rulers, measuring cups, spoons, tape measures, etc. that can be used to create real-life problems. McDevitt states:

Another suggestion is that you use authentic materials, supplied by the learner if possible, to enhance your instruction and increase the learner’s understanding. If we begin by asking why the learner wants to learn math, we not only establish a new context but we also begin to reframe our instruction as numeracy rather than simple math. For example, in real life, math problems are complicated; they use real numbers that can be messy, and there is rarely only
one way to get the answer. So another suggestion is that you conduct your classes to encourage development of problem-solving skills that will be useful beyond the classroom walls. Encourage learners to wonder why things are, to practice solving problems even when they are not familiar with or aware of procedures, to solve problems in a variety of different settings, and to use what is familiar to them to explain what is not. (2001, p. 5)

Extend students’ skills in measurement and geometry by determining acceptable tolerances, usually in the form of upper and lower limits. Just as the consequences of driving on a tire that is under-inflated or over-inflated can be very costly, many workplace situations as well as personal life applications dictate actions when measurements fall outside an acceptable tolerance range.

One instructional goal should be the enhancement of spatial reasoning skills. Spatial reasoning requires measurement and geometry skills plus the ability to visualize shapes. Many have unrecognized spatial reasoning skills, particularly artistic students.

Build on students’ prior knowledge. Geometry may be the best example of the opportunity and value of doing so.

**Teach Algebra**

How can we avoid algebra? It is an unfortunate fact that many Adult Basic Skills students would like to do just that. It is even more tragic that many instructors share those sentiments. However, there is a way to skirt around, if not totally avoid, the stigma attached to the word *algebra*.

DO NOT begin with algebraic equations such as $x + 3 = 5$. When students see a variable in an equation their math thought processes go blank and math anxiety kicks in. Almost all students will be able to tell you what number added to three gives a sum of five. Students can learn algebra concepts before they even have to hear the word *algebra* and before they ever see an algebraic equation such as $x + 3 = 5$. As students grasp this concept, make the problem practical. If all the players on a basketball team are late
except 3, how many more players must arrive before 5 players can be put on the court? That is the same exercise as \( x + 3 = 5 \).

Approach algebra by completing simple word problems, and then write the problems as algebraic equations. It may be necessary to complete many such exercises to convince students they really can do algebra, and it is very important to do so.

According to Curry, Schmitt, & Waldron (1996):

Algebra supports the key purposes for literacy. How can algebra be a door-opener rather than the gatekeeper to higher education and well-paying jobs? Skills and knowledge in the area of algebra help adults access information that is presented in written and oral mathematical symbols. Conversely, the ability to represent information and relationship with algebraic symbols, graphs, or everyday language strengthens voice. The ability to reason algebraically (to think logically), to recognize patterns and generalizations, provides a scaffold for problem solving and decision-making. (p. 56)

Algebra is a bridge between arithmetic and more broadly generalized mathematical situations. Mathematics is the study of patterns. “Learning to recognize and analyze patterns and number relationships connects math to the world” (Leonelli & Schwendeman, 1994, p. 42). Generalizations can be expressed as formulas and graphs; many life experiences can be expressed in algebraic terms.

Teach algebra by letting students set the pace. Of course, students must be stimulated to continue working and learning, but advancing to a new topic before students are ready may generate failure, especially if students have experienced “being lost” in previous classes.

Consider using group work and collaborative learning to teach algebra. The most effective way to learn is to explain something to someone else. Students who talk about algebra gain a better understanding of the concepts which leads to confidence in their own abilities.
Teach Probability

Just as students are surrounded by math, so they are surrounded by probability. We hear and see probability applied practically every day. Probabilities appear as percentage estimates of the chance of particular events, and practically everyone uses chance to discuss the likelihood of something happening. During election years we frequently hear predictions and voting percentages based on poll results. News broadcasts and newspapers report statistics on the percent of people who do or do not favor something.

“Employers are clear about the need to understand and use decimals, fractions, and percents” (Curry, Schmitt, & Waldron, 1996, p. 37). Students practice by working with probabilities. Probabilities can be expressed in fraction, percent or decimal form. Weather reports traditionally use percents, such as, “There is a 30 percent chance of rain tomorrow.” The student who does not realize that 30% is considerably less than 50% may assume it is going to rain when actually there is a 70% chance that it will not rain.

About 25% of smokers die in middle age of an illness that is known to be caused by smoking (McManus, 2003). For smokers, this number can be interpreted as a probability that they will meet the same fate. Smokers who know and understand probability must choose to stop smoking, ignore the probability, or make light of it with rationalizations such as, “We all have to die of something.” Of course, some of these same people will bet on the lottery where the odds against winning are astronomical. For example, the probability of successfully guessing three numbers where each is a single digit (0 through 9), as in “pick 3”, is one in one thousand or one-tenth of one percent. The chance of winning other lottery drawings is considerably smaller than 0.1%.

Baseball fans know that batting averages, earned-run averages, and winning percentages are expressed in decimal form. These statistics are often used comparatively to determine which individual or team is better, but most baseball fans have gained perspectives on what “percent” would be considered “good,” even if it is less than 50%. For example, a batting average of .400 or above
is considered phenomenal. Batting averages are an example using decimal notation to indicate statistics and probability. By convention, the batting average is rounded to the nearest thousandth, so a batting average of .345 means the individual has gotten a hit 34.5% of the times he has batted during the time represented, usually the current season. If no other information was available, such as batting slumps, the identity of the pitcher, or the handedness of the pitcher and the batter, one could interpret a batting average of .345 as a 34.5% probability of a hit the next time the batter is at the plate. The use of decimal statistics is not unique to baseball. Many other sport statistics also take that form.

When tossing a single die, the probability of getting a given result (say a “5”) is 1/6. In this example, it is definitely easier to describe probabilities as fractions, rather than as decimals or percents. What proportion of die rolls would be expected to result in a five? The answer is one out of six.

How many heads would you expect if you tossed a fair coin 10 times? How many girls would you predict in a family with 5 children? If a new cancer treatment estimated to reduce the recurrence rate by 32% more than the old treatment is given to 50 people, how many lives might be saved? If 10% of the light bulbs in a display sign fail during the first 6 months, and the sign has 42 bulbs, how many replacement bulbs should be ordered?

Determining expected values has both workplace and personal applications. At least three skills are involved. Students must be able to identify the total number of trials and the probability of a particular outcome from the data available. Students need arithmetic skills to calculate percents or fractions of the total number of trials. Finally, students must be able to state the result in as a logical answer. For example, 5 might be a logical answer for the number of heads expected from 10 tosses of a fair coin, but 2.5 girls in a family of 5 children is not a logical answer. Very few families actually have 2.5 girls. A more reasonable answer would be 2 or 3 girls. In the question about the number of light bulbs that should be ordered, it would not be a good idea to tell the
boss (or anyone else) to order 4.2 light bulbs. A much better answer would be “at least 5 bulbs.” That answer would demonstrate that the student/worker knew that rounding up would be more appropriate to this situation than rounding to the nearest whole number, and that the student/worker realizes that more bulbs might burn out than is predicted by the estimate.

**Teach Statistics**

More than any other area, the study of statistics incorporates a wide variety of math skills and practical applications. The *Massachusetts ABE Math Standards* state, “Adult learners need to have the opportunity to systematically collect, organize, and describe data; and construct, read, and interpret tables, charts, and graphs” (Leonelli & Schwendeman 1994, p. 50).

“Adults, often without even realizing it, make decisions based on statistical information. It may be via the television, radio, or it may be through print materials” (Curry, Schmitt, & Waldron, 1996, p. 43). Many people design graphs to illustrate statistical information, and often make decisions based on graphical representations of information. “Statistical information is used to communicate information and sometimes influence others. Understanding the flood of statistical information allows adults to make more informed decisions” (p. 44).

**Mode.** Mode is defined as the most frequently occurring value or values. Mode is easily demonstrated and understood. Count the number of times each value occurs to determine which value occurs most often. Counting and ordering skills are enhanced.

Although the mode is not a reliable indicator of the “middle” when using a small sample (Kitchens, 2003), it is very meaningful for larger samples. For example, if you ask the class to determine the mode of ages of students in the class, the mode might turn out to be the youngest age, because no more than one student is any other specific age, such as 30. This exercise would demonstrate how to find the mode, and just might show that the mode is unreliable as an indicator of the “center” of a small sample.
The instructor can enhance that illustration by asking what the result would have been if a specific person, or two specific people, had been absent.

Values tend to concentrate around the “center” of a distribution. Most students agree that there are more 5 foot, 10 inch men than there are 6 foot, 10 inch men. For most measured variables, the average is much more common than the extremes; this is true of most size and speed measurements, as well as test scores. Students should be taught to ask, “Is the mode a good indicator of the center in this situation?” (Curry, Schmitt, & Waldron, 1996, p. 41).

Students gain a better understanding of the mode if they learn to determine the mode of a sample of manageable size. The mode often becomes apparent after the values are arranged in either ascending or descending order. Students can make frequency tables to illustrate that the value with the highest frequency is the mode.

Frequencies are counts of the number of times a particular value occurs in a data set and helps determine mode. The frequency table below is from a statistics course taught by the author. What is the mode? The mode is one sibling.

<table>
<thead>
<tr>
<th>Number of Siblings</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>1</td>
<td>14</td>
</tr>
<tr>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>6</td>
<td>1</td>
</tr>
</tbody>
</table>

Another valuable skill is determining the mode from a frequency plot, such as a line graph, or frequency curve. Understanding that the tallest line or lines on a line graph occur at the mode or modes helps students appreciate what is illustrated by a line graph and how to read values on the X-axis. These skills are easily transferred to the reading of a frequency curve, where students can determine the mode or modes by visualizing, or
drawing, a perpendicular from the highest point(s) to the X-axis. “Reading charts and graphs, interpreting the data, and making decisions based on the information are key skills to being a successful worker and an informed citizen. Being an informed citizen includes understanding statistics and probability as well” (Curry, Schmitt, & Waldron, 1996, p. 41).

Some data distributions are bimodal, meaning that they have two modes. Although the distribution of values for females and males often overlaps so much that there is only one mode, there is the potential for bimodal distributions in human measurements with one mode for each sex. That is true of body weight because males and females have distinct modes. It should be noted that classroom illustrations of weight data should be done with fictitious data and still may be embarrassing to some class members. An alternate example would be a skill, such as typing speed. In some skill activities, there would be one mode for those who have had training and another mode for those who have not.

Median. The median is also a simple concept to illustrate and understand. The median is the middle value when data are arranged in ascending or descending order (Kitchens, 2003). A good way to illustrate this concept is to ask class members to line up by height and count to the middle individual. Since the median is most obvious when there are an odd number of individuals, the instructor may choose to be part of the “line-up” if the number of students present is an even number, or can ask one class member to direct the activity rather than participate.

When the number of data points is an even number, the median is correctly determined by “averaging” (i.e., finding the mean) of the two individuals in the middle. Students should be able to find the median from any list of values provided. The instructor should ask students to find the median of at least one unordered list, so students become fully aware that they must first arrange the values in rank order.

As sample size increases, locating the median becomes a more tedious activity and the mode becomes more reliable as the sample size increases. Students then learn to make judgments about which statistic is a better choice.
There are situations in which the median is the preferred statistic, because the mode and the mean (which many people call the average) do not adequately describe the variable being studied. This is true when the data is significantly skewed, such as may (but may not) be true of ages of class members. If the mode is at one of the extremes, students can readily see why the median is a more appropriate value for finding the “center” of a small sample. Another example can be obtained from data on income of Americans. The mode would be a very low income, and the mean would be too high to be a good description of income of Americans because the extremely high incomes of Bill Gates, Oprah Winfrey, etc. add so much to everyone’s total income. Because of a few extremely high values, over 90% of Americans earn a “below average” income. Using the median to locate the middle income provides the most meaningful number.

Mean. The mean, or more correctly the arithmetic mean (there are other means including the geometric mean and the harmonic mean), is called the “average” by most non-statisticians. Mean is the correct name, because the broad definition of the word “average” would allow it to be used for any statistic that might approximate the “center” of the data (Kitchens, 2003).

The calculation of the mean is taught early in the public schools, and most students know how to average a set of values. The mean is equal to the sum of the values divided by the number of values. For example the mean of the values 3, 7, and 8 is 6, because

\[ \frac{3 + 7 + 8}{3} = \frac{18}{3} = 6 \]

Calculation of the mean for a larger sample is simply a matter of working with more numbers.

One shortcut is to calculate the mean of a frequency table by adding a column for “value times frequency.” The new frequency table has been reproduced on the following page.
The mean number of siblings is $45 \div 31$, which equals $1.451$.

The calculation of statistics from a frequency table can be contrasted with the calculation of the same statistics from an unordered list by asking the students to complete the calculations on a list of the same 31 values. This demonstration will be more effective if students calculate from the list before the frequency table, or without knowing they are the same values that were summarized in the frequency table.

**Upper and lower limits.** There are many situations in which it is important to know the lowest and highest values. In some cases, such as the data in the frequency table, the minimum value can be predicted before the data is collected. Zero is often the obvious minimum, but not always.

Knowing the minimum and maximum allowed gauge readings in the workplace may allow workers to be alerted by unusually low or high readings. Sometimes such values need to be identified by observing a recording chart that makes a running graph of readings.

### Teach Charts and Graphs

Charts and graphs are essential in the workplace. Often frontline employees are required to collect the data used for charting the manufacturing process; therefore, employees at all levels should be knowledgeable about and comfortable with a variety of charts (Curry, Schmitt, & Waldron, 1996). According to SCANS
documentation, tomorrow’s workers must have reading skills that enable employees “to read well enough to understand and interpret diagrams, directories, correspondence, manuals, records, charts, graphs, tables, and specifications. Without the ability to read a diverse set of materials, workers cannot locate the descriptive and quantitative information needed to make decisions or to recommend courses of action” (1991, p. xvi).

Adequately reading gauges helps determine trends and direction of change. However, be alert to deception when trends are made to appear more or less dramatic by expanding or collapsing the scale of the Y-axis.

Get a laugh from the class by illustrating this concept with a fictitious graph of percent of students who think you are a good instructor, by showing a theoretical increase from 55% to 60% (or whatever values you choose to use) in one graph with the Y-axis beginning at 0 and another with the Y-axis beginning at 50%. Students should practice reading both axes on various types of graphs. As students practice reading and designing graphs and charts and collecting and summarizing data, they utilize most if not all basic math skills and add to their number sense.

**Comparative graphs.** Students should learn to make and read comparisons of categories shown in simple graphs. Comparison graphs often use different colored bars for comparing data, such as morning and afternoon productivity. Several days might be plotted on a graph. Students should look for the higher color-coded level. They should also be able to state when there is no real difference. Finally, they should look for a decreasing or increasing trend from left to right.

Students should be taught to make comparisons from bar graphs and pie charts (also called circle graphs). Not only should students be able to identify the most frequent classification by finding the tallest bar or the largest slice, but they should also be able to rank order the classifications and compare frequencies. In a
pie chart it is merely a matter of determining what proportion one slice is of another, i.e. if one slice is twice as large as another, three times as large, only slightly larger, etc.

**Making graphs.** The ability to make bar graphs is dependent on students’ abilities to identify the X and Y-axes, index the axes properly, and locate intersections given X and Y values. The same skills are necessary for students to plot data showing relationships between the two variables plotted on the X and Y-axes.

Graphs and charts touch on all areas of math and numeracy. *Massachusetts Adult Basic Education Curriculum Frameworks for Mathematics and Numeracy* states the following:

> We learn about preferences, predictions, and group characteristics when we read and interpret data. We learn about the power of evidence as we develop the skills to make statements and evaluate arguments based on data. We learn the power of the question and the framer of the question when we collect and represent data, and we learn that sometimes true, sometimes false, pictures are created when we compress data into statistics. Data is a powerful descriptive tool. (Donovan, Goodridge, Froelich, Leonelli, Moses, Mullen, et. al., 2001, p. 18)

Instructors must provide experience collecting, organizing, and interpreting data. It is not enough to give learners practice in simply reading charts and graphs. To give adult learners a better understanding of graphs and charts, they need to actually gather data, interpret results, and decide how to represent information in charts and graphs.
Use Collaborative Learning to Teach Problem Solving

Prior classroom experiences probably taught learners that working with other students is equivalent to cheating. The latest work in cognitive psychology points to the importance of social interaction for effective adult learning. Develop collaborative learning groups. Using class discussions in addition to collaborative learning reassures students of the value of learning together. It also gives students the chance to become more skillful in group discussion and problem solving.

Adult students have the capacity to help and encourage their peers. In fact, many respond much better to guidance from other students than to direction from the instructor. In collaborative learning, students model problem solving techniques that may be adopted by others. Collaborative learning fosters shared responsibility in order for all group members to make satisfactory progress. Rewards take the form of self-satisfaction.

The challenge is forming the most effective group learning environments. The choice of exercises and timely guidance has major effects on the learning environment of a collaborative learning group.

The most effective way to learn and understand math is to explain it to someone else.
Collaborative learning can be used effectively in any subject matter and is especially valuable in problem solving. The instructor should group students to work on concepts they find difficult. Having heterogeneous groups allows students to teach each other. Simply hearing a concept in different words from those used by the instructor may be a key to learning for some students. Sometimes students who just learned a concept are better able to explain it because they see it on a simpler level and are more cognizant of the blocks to understanding. Of course, the instructor needs to closely monitor the progress of collaborative learning groups and look for occasions to clarify basic ideas, thus enhancing groups’ progress.

Collaborative groups are especially effective tools in the struggle to counter and correct math anxiety. Students can build self-confidence from successful group problem solving activities and assignment completion. Students who suffer the greatest degree of math anxiety avoid the “spotlight” as they develop their own skills. Success is enhanced by the alternate learning opportunities provided by the various problem solving approaches portrayed in group discussions. The emotional support and academic assistance provided by the group is especially important for adult students.

Use Inquiry to Teach Problem Solving

Inquiry opens worlds of learning for many adult students. When students succeed with the inquiry approach, they simultaneously develop self-confidence that translates into enhanced successes both in and out of the classroom. The inquiry method requires students to collect their own data, then draw inferences and reach conclusions for themselves.

Investigating math related writing samples or math problems effectively teaches the grammar of mathematics. Students progress from framing questions to developing hypotheses about the patterns they observe. The instructor can guide these steps or encourage further investigation to evaluate the hypotheses formed by the students. The instructor should interact before students reach conclusions to insure that the evidence has been correctly
interpreted leading to the correct conclusions. A major advantage of this approach is the teaching of problem solving and critical thinking skills that are invaluable in careers and life decisions. Inquiry addresses a unique learning style, allowing students who might not succeed with other teaching methods to achieve greater success.

Teach How to Communicate Math

Math is language. *A Framework for Adult Numeracy Standards: The Mathematical Skills and Abilities Adults Need to be Equipped for the Future* states the following:

Mathematical communication is an overarching process which includes understanding, expressing, and conveying ideas mathematically in order to reflect on and clarify one’s thinking, to make convincing arguments, and to reach decisions. As noted in *What Work Requires of Schools*, a SCANS Report for America 2000, arithmetic and mathematics are essential basic skills and part of the foundation each worker needs to be successful. Effective workers must be able to interpret and communicate information and communicate ideas. Good mathematic communication is like all other effective communication requiring listening, speaking, reading, and writing skills along with interpersonal skills. (Curry, Schmitt, & Waldron, 1996, p. 22)

This communication is often explaining, and perhaps advocating, a particular position.

Without communication there would be no teaching or learning of math. Students learn to communicate the results of math computations, as well as communicate a lack of understanding and the need for help.

In math, essential communication defines problems and possible solutions. In the workplace problems are solved through group efforts, so the ability to communicate is a valuable skill.
Curry, Schmitt, & Waldron (1996) states the following:

As a skill necessary for future employees, students should be able to express mathematical ideas and concepts orally and in writing. Also very few employees will work totally by themselves. More and more, work will involve listening carefully to clients and co-workers and clearly articulating one’s point of view. (p. 31)

Teach Students to Think

The most important goal of an Adult Basic Skills instructor is to teach adults to function effectively and efficiently in the workplace and in everyday life. Adult Basic Skills students need to learn to see and explore alternatives, to inquire about the nature and ramifications of problems, and to discover mathematics as it is used in society as a whole. In Everybody Counts, a report to the nation on the future of mathematics education, the National Research Council (1989) issued the challenge to:

- produce citizens with sufficient mathematical literacy to distinguish evidence from anecdote,
- recognize nonsense,
- understand and appreciate the concepts of probability and chance, and
- value the notion of proof.

These and other critical thinking skills enable adults to function effectively in today’s society.

Blend Math Principles and Skills

The old way of teaching math was to teach basic skills before teaching problem solving skills. However, those two skills go hand-
in-hand and should be taught together. Each can reinforce the other.

The most effective way to learn math is by exploration and development of one’s own techniques for problem solving. That process often seems too inefficient for the classroom. Many students have devised skills and strategies that should not be discarded so that everyone can do things “the instructor’s way.” Why scrap good knowledge and start over? Students may choose to learn new techniques and approaches, but they should be allowed to retain and build on those they have discovered and mastered.

Students can learn both concepts and skills through problem solving. Students learn new skills and concepts while they solve problems. Approach sophisticated mathematical skills by treating them as a problem to be solved. Grouws and Cebulla (2000a) suggests that it is not necessary for teachers to focus on skill development and then problem solving; both can be done simultaneously. Skills can be developed on an as needed basis, or their development can be supplemented through the use of technology. In fact, “there is evidence that if students are initially drilled too much on isolated skills, they have a harder time making sense of them later” (p. 2).

According to Grouws and Cebulla, giving students both an opportunity to discover and invent new knowledge and an opportunity to practice what they have learned improves achievement. Balance is needed between the time students spend practicing routine procedures and the time they devote to inventing and discovering new ideas. Instructors need not choose between these. To increase opportunities for invention, instructors should frequently use non-routine problems, periodically introduce a lesson involving a new skill by posing it as a problem to be solved, and regularly allow students to build new knowledge based on their intuition and informal procedures. “Teaching that incorporates students’ intuitive solution methods can increase student learning, especially when combined with opportunities for student interaction and discussion” (p. 3).
Encourage Participation

The Massachusetts ABE Math Standards state,

Computation skills should be practiced in the context of problem solving and not as a set of isolated skills. Adults should be encouraged to develop and share their own tricks and ways of computing percentages; for example, sharing short-cuts to determining the tip on a meal tab or finding a discount. (Leonelli & Schwendeman, 1994, p. 40)

Encouraging students to share procedures is an invaluable technique for overcoming math anxiety.

Adults also need to feel comfortable expressing their frustrations with math. The instructor should strive to create an environment that encourages students to talk about math and about the problems they are experiencing. It helps both students and instructors to evaluate and adjust the pace of instructional and learning activities.

Math is problem solving. Life is repeating patterns of reasoning and decision making to solve problems. When math class teaches reasoning, decision making, and problem solving skills it better prepares students for life.

Encourage learners to wonder why things are, to solve problems in a variety of different settings, and to use what is familiar to them to explain what is not.
The value of a problem is not so much coming up with the answer as in the ideas and attempted ideas it forces on the would be solver.

I. N. Herstein
Introduction

Math instruction in Adult Basic Skills classes has never been an easy endeavor. Adult learners traditionally have difficulty relating textbook lessons to practical, real situations. In fact, Adult Basic Skills students often see little benefit in traditional math lessons (Curry, Schmitt, & Waldron, 1996). Using traditional approaches to teaching math causes three predictable problems.

1 Adult learners often fail to see the usefulness of skills taught from traditional textbooks with traditional approaches. Therefore, instructors must apply math to the real world.

2 Math classes lack motivation. Non-engaged adults express feelings of frustration, hopelessness, disinterest, and disconnectedness. They see little relevance to their situations and, as a result, experience little success. Lack of success creates additional problems; a lack of previous learning creates mental obstacles to future learning.

3 Students never learn the relevance and application of math in their everyday lives. Because they never grasp the transference of traditional math to the real world, students often feel inadequate in the vital areas of problem solving and decision-making. (Curry, Schmitt, & Waldron, 1996)

These three problems are much less likely to develop when the instructor strives to make math real by using realia. Realia is any authentic material or activity that relates to students’ background, knowledge, and real life. Some researchers identify realia as those materials that naturally exist in students’ lives (Ahlstrom, 2003). Realia includes materials such as:
The use of realia enables most students to transfer math skills to real-life situations. A Literacy Practices of Adult Learners study found that when students participated in real-life activities using authentic materials, they felt more engaged, successful, and comfortable expanding their skills outside the classroom (Jacobson, Degener, & Purcell-Gates, 2003). Another study, A Framework for Adult Numeracy Standards, found that adults learned math more effectively when lessons were relevant to real-life situations (Curry, Schmitt, & Waldron, 1996).

The use of realia motivates and engages students in the learning process. Several studies found that involving adult students in planning and collecting realia, as well as in the identification of needs and strategies, resulted in higher levels of engagement and achievement (Curry, Schmitt, & Waldron, 1996; Ahlstrom, 2003; Jacobson, Degener, & Purcell-Gates, 2003; Hiemstra, 2004). Adult learners remain motivated when they have
a stake in learning, see a connection to real life, and have an opportunity for collaboration. Realia provides all of these benefits.

Problem solving and decision making using realia provides opportunities for meeting the diverse needs of adult learners. The Ohio Mathematical Planning Committee Report (1996) noted that since math is everywhere learners need to perform hands-on problem solving activities to connect with real-life situations. Roger Hiemstra (2004) states that problem solving is most effective when students are involved in concrete, practical activities that relate to prior knowledge and experiences. The Adult Numeracy Standards study (1996) found that adults were more likely to be successful in math and problem solving when their activities were directly related to real situations (Curry, Schmitt, & Waldron).

One word of caution is necessary; studies cited here report many examples of realia use in which adult learners were not able to make connections between lessons and real-life. Adult Basic Skills instructors must connect real-life to instructional activities and materials. One approach relates realia to the work-related experiences. Students given the opportunity to choose and collect materials and activities were more likely to make the math connection to work-related experiences (Curry, Schmitt, & Waldron, 1996; Nowlan, 2004; Hiemstra, 2004). Moreover, students experienced more success in math classes where collaboration and realia were daily activities.

*Sharing workplace applications helps students see dramatic and concrete reasons for improving math skills.*
Realia in the Workplace

Sharing benefits everyone. Sharing workplace applications helps students see dramatic and concrete reasons for improving math skills. Since much of the work force now uses basic algebra and geometry, the importance of math becomes practically impossible to ignore.

The variety of workplace applications is endless. In our free enterprise society essentially every workplace provides money applications in forms of costs, profits, or budgets. Figuring taxes is only one example of the application of percents in the workplace. Workers may need to employ measurement skills, read charts and graphs, prepare statistical reports, calculate quantities of ingredients or other materials, or compute costs. Cost computations may include time estimation and cost comparison as well as calculations related to overhead costs, insurance costs, salaries, and benefits. Each should be the resource for a realia lesson.

Many workers identified ways to make their company more efficient, and hence more profitable, but they do not know how to sell their ideas to management. They can be encouraged to quantify their ideas and share them with classmates who then provide feedback on the style and format of a formal recommendation, thus verifying the idea’s potential in economic terms.

If you get a 3% raise, how many more dollars will be in your paycheck? This question provides opportunities for creating word problems related to percent calculations and organizing numbers. What would happen to your paycheck after a 5% tax cut? This situation generates another interesting set of questions. Similar questions can be asked about personnel costs to a company. How do company changes affect the county budget?

There are many workplace applications using fractions. Converting production costs from a per day to a per hour basis might involve a one-eighth
calculation. Fractions are needed to figure weekly time cards. Ordering parts and mixing ingredients might involve fractions.

Workplace realia includes completing applications, tax forms, work orders, and other work-related forms. Math is embedded throughout the workplace.

**Realia in the Home**

There are many practical examples of the use of math in the home including calculating living expenses, income and investments, interest rates, and payment plans. Many Americans count calories or carbohydrates, thus contributing math examples related to nutrition. Adjusting recipes for different numbers of people provides a need for fractions and multiplication problems. Students may be anxious to provide their own practical application materials.

Although some students may not be particularly interested in all practical applications to family life, they will be interested in many of them. Dividing the class into collaborative learning groups insures that class members have opportunities to work with applications that fit their personal interests and family situation.

How much more will an automobile cost if you finance for one additional year or pay down $1,000 less? This problem requires calculation of additional costs and sales tax. How much more (or less) would it cost to purchase one of the new hybrid vehicles? How long will it take to recover the cost from improved gas mileage?

The above realia applications can be enhanced by pamphlets, brochures, and advertisements or by meeting at a grocery store, restaurant, or other business establishment. Restaurant chains often provide menus and nutritional information for adult classes. The class could publish a cookbook and include recipes for different numbers of people, such as spaghetti for two or spaghetti for 20.
Realía related math activities using family finances might include checking and savings account records, credit card bills, repair bills, utility bills, food labels, calorie charts, paint charts, rent leases, and catalogs. Students can locate and collect other realía after being shown examples.

Applicable realía can also be found in hobby and leisure activities. Adult students are often shocked to learn how much math they use in their leisure activities. Puzzles and board games invariably involve geometric shapes, counting, and other simple mathematics. A significant amount of math is involved in keeping score and planning strategies when playing or watching sports. Activities such as sewing, cross-stitching, stamp collecting, scrap booking, or gardening have numerous math applications which can easily be brought into the Adult Basic Skills classroom.

A leisure activity such as planning a family vacation may be an excellent realía math project for Adult Basic Skills math class. There is an endless number of tasks in which the students can calculate, ranging from the estimated cost of the vacation to estimating the amount of exercise it will take to burn off the calories consumed while on the vacation. Map reading, travel route selection, lodging costs, entertainment, and food expense can have valuable real-life applications. Even simple leisure activities, such as going to a movie, playing putt-putt, or examining bowling scores provides numerous opportunities for teaching math.

The math of music, architecture, or photography can be quite sophisticated; however, using basic problems from these and related areas allows adult students to feel they are completing practical problems while impressing them with the diverse applications of mathematics. Again, one can make
these activities more meaningful by supplementing them with realia, such as cameras, pictures, maps, and games.

**Conclusion**

The typical adult learner experiences frustration in the Adult Basic Skills math class due to an inability to relate material to real life. Using realia allows adult students to see math as a relevant and practical skill. It also allows students to see how much math they already know, thus helping to alleviate math anxiety. Using realia in the classroom is an excellent strategy for alleviating frustration with math and better preparing adult learners for the workplace, real life, and even GED or Adult High School completion.

Students may provide realia, or it may be supplied by donations of relatively inexpensive material. Realia can be very budget friendly.

The benefits of realia include the opportunity to explore the endless variety of math applications to the real world and to illustrate how much math adult students use and need in their lives. When realia is used, learners become successfully engaged in learning. In fact, the Literacy Practice of Adult Learners Survey states, “Bringing the lives, needs, and interests of the students into the classroom is an integral part of best practice” (Jacobson, Degener, & Purcell-Gates, 2003). Best practice can be implemented when the instructor thoughtfully and deliberately integrates realia in teaching and learning activities.
Chapter 7

Project–based Teaching and Learning

Dianne B. Barber
Rebecca K. Sanders

The moving power of mathematics is not reasoning but imagination.
Augustus De Morgan
Introduction

As instructors we constantly search for alternative ways to deliver instruction. Variety invigorates the class. We learn early about learning styles and, therefore, develop a variety of teaching methods. How can we involve reluctant learners in classroom activities or difficult subject matter? We have found project-based learning (PBL) to be an effective approach.

While enrolled in a graduate course in “Action Research” one of the authors had an assignment to identify a problem within the classroom, research possible solutions, and then choose and apply a solution. She completed that assignment by substituting PBL for traditional instruction after her Adult Basic Skills students voiced their dislike for science. The results were astounding. Even though the curriculum category was science, math was involved. For instance, one team chose a project in nutrition involving a significant application of math. PBL can be used effectively for simultaneous instruction across disciplines.

The same author is now using PBL in math by having students design a handicap-accessible house. The other author has had math classes design a quilt, plan a garden, and help figure materials needed and costs associated with building a house.

Project-based learning involves a group of learners taking on an issue close to their hearts, developing a response, and presenting the results to a wider audience.
Project–based Learning (PBL)

In an article entitled, *Knowledge in Action: The Promise of Project-Based Learning*, Wrigley (1998) says, “In its simplest form, project-based learning involves a group of learners taking on an issue close to their hearts, developing a response, and presenting the results to a wider audience. Projects might last from only a few days to several months” (p. 1). Moss and Van Duzer (1998) state that PBL “contextualizes learning by presenting learners with problems to be solved or products to develop” (p. 1). The learners work together to reach a suitable solution or conclusion. The collaborative aspect of PBL is consistent with our understanding of learning as a social activity that occurs within the context of culture, community, and past experiences (*Buck Institute for Education Project Based Learning Handbook*, 2002). The Buck Institute for Education *Handbook* also states, “PBL can help you as a teacher create a high-performing classroom in which you and your students form a powerful learning community focused on achievement, self-mastery, and contribution to the community” (p. 6).

The goal of PBL is more than creating interest; it is creating excitement for learning. This strategy lets students select a topic that is interesting and relevant to them. Projects involve students in using their personal learning styles, resulting in a greater level of learning (Railsback, 2002). PBL draws upon advantages of both cooperative learning and inquiry/discovery instruction.

In an article entitled, *Inquiry/Discovery: Captain Cook*, Barnett (2004) describes inquiry/discovery as a teaching/learning process based on the following four steps.

1. Define the problem for study.
2. Draw inferences/develop hypotheses.
3. Test each inference/hypothesis.
4. Draw a conclusion/solution to the problem of study.
These four steps are equally appropriate to cooperative learning. When cooperative learning is properly facilitated, students benefit from one another’s strengths and efforts. They also seem to forget differences and come together to achieve common goals. The combination of these strategies in PBL allows students to simultaneously learn subject matter and gain social skills needed on the job.

An article by Robert J. Stahl (1994) entitled, *The Essential Elements of Cooperative Learning in the Classroom*, outlines the elements needed for cooperative learning:

1. A clear set of specific student learning outcome objectives.
2. All students in the group ‘buy into’ the targeted outcome.
3. Clear and complete set of task-completion directions or instructions.
4. Heterogeneous groups.
5. Equal opportunities for success.
7. Face-to-face interaction.
8. Positive social interaction behaviors and attitudes.
10. Opportunities to complete required information-processing tasks.
11. Sufficient time is spent learning.
12. Individual accountability.
14. Post-group reflection (or debriefing) on group behaviors. (p. 2)

This exhaustive list summarizes the literature. Of course, meeting all these specifications can be quite challenging.

- K is what the student **knows**;
- W is what the student **wants to learn**;
- H is **how** the student will learn the material and work with others to attain goals;
- L is what was **learned**; and
- S is how the information was or will be **shared**.

Ngeow employs this strategy to insure that student goals benefit individuals while contributing to the group’s common goal. Since cooperative efforts are central to PBL, the instructor must be familiar with cooperative learning elements and effective strategies.
Implications for Numeracy

Instead of using most of the math class time to demonstrate mathematical procedures, and assuming the student will remember all the steps long enough to practice them, PBL creates opportunities for active learning and immediate application to the real world. PBL also creates context in which students want to solve mathematical problems. This is a valuable step in the attainment of a larger goal. By getting students to ask how, or at least look forward to learning how, to complete the necessary mathematics for a particular task, the instructor taps into the natural desire to learn while alleviating math anxiety. Although the desire to learn could be inspired by an interesting individual project, cooperative and class projects are especially effective.

D’Ambrosio coined the term “ethnomathematics” in 1985; he used this term to describe mathematics as practiced by cultural groups and professional classes. Most Adult Basic Skills classrooms are well suited for ethnomathematics. When there is significant cultural diversity in a class, the instructor can tap students’ backgrounds to obtain examples of their math needs as well practical applications.

A class project with multicultural applications might be the planning and planting of a vegetable garden. Of course, this project is suited to a homogeneous group, but a multicultural group makes for a very interesting selection of vegetables. Either way, the alert instructor can find many mathematical applications in the calculation and measurement of plot layout, planting depths, fertilizer applications, etc. The problems that can arise during the planning process take the form of word problems, even if they are not written. Students might be amazed to learn they solved word problems throughout the project.

A team approach is appropriate for this project. One team can research and propose fertilizer applications. Another team can select the necessary and research the costs involved. A third team could design the garden layout. Determining the area needed to grow each type of vegetable and the cost of seeds or plants is a good team project. Finally, a team can determine how to use the produce of the garden and possibly how to recover expenses.
Planning and producing a vegetable garden challenges students to develop skills in estimating, counting, classifying, recording, comparing, and measuring. Students learn geometric shapes and determine areas and perimeters. Most students need improvement in estimation and measurement while sorting, classifying, and recording may be new experiences. Class projects also provide skills in cooperative problem solving.

Another class project with multicultural applications is planning and making a quilt. An instructor can find many mathematics applications in the calculations of quilt size, block size, amount of material needed, and investment in terms of cost and time. Again, the planning process can provide word problems which could be written, giving practice in communication. The students are challenged to use skills in addition, subtraction, multiplication, division, fractions, percents, measurement, pattern recognition, and working with geometric shapes. This project also provides opportunities for working together.

Other potential PBL activities can create cooperative problem solving opportunities. The students might enjoy planning and preparing a meal or a party for a large group. Vacation or long trip planning can provide numerous math activities. Students can design a park, playground, or landscape plan. Moss and Van Duzer (1998) reported that their students created a children’s coloring book. Wrigley (1998) reported that her students developed a lunch sharing plan which culminated in a catering business. Possibilities are endless.

Real-life math might involve conducting a survey to determine topics about which the students would like to learn. Students can select an area of finance, become the experts, and then share their knowledge and skills with classmates. Valuable understanding of budgeting, salaries, buying a car or house, grocery shopping, and personal banking is needed by the students.

Have students pick a destination; then plan for a trip. They can choose transportation, date, activities, and lodging. They can develop expense charts, timelines, and budgets.
In geometry, consider designing a house, school, park, downtown revitalization project or perhaps a school campus. Require the use of specific geometric shapes and formulas in designing 3-D projects. Toothpicks, straws, clay, etc. can be used in designing simple or complex projects depending on class level.

Another project-based geometry experience is to redesign or redecorate the classroom or building. Teams may be responsible for flooring, walls, furniture, art, etc. Ownership and collaboration are positive by-products of project-based learning.

**PBL in the Classroom**

Most PBL projects involve selecting a topic, planning the project, researching, developing, and reporting results (Moss & Van Duzer, 1998). Sharing projects and celebrating learning with peers generates enthusiasm, great pride, and a sense of accomplishment. (Wrigley, 1998; Moss & Van Duzer, 1998). The students are even likely to admit that learning has been fun.

PBL projects provide opportunities for students to work with real-life situations where there is usually more than one correct answer. Students evaluate multiple solutions and develop skills in assessing alternatives. Project involvement supports math efforts. This teaching approach is especially beneficial because students not only learn to perform mathematical procedures, but they also practice choosing appropriate procedures and making applications.

“Once a project is selected, learners work together to plan, conduct research, and develop their products” (Moss & Van Duzer, 1998, p. 2). “As learners get involved in the inquiry process, they become curious about answers, often digging deeper into a topic and spending more time on task than they do when a teacher assigns group work” (Wrigley, 1998, p. 6). The authors have observed that PBL increases student bonding, even among friends.

Reading skills often limit the ability to solve word problems. Using PBL creates situations where word problems are written or voiced by the students. Students become aware of the practical nature of word problems, and thus, become more comfortable
solving them. Successful completion of project-based learning experiences contributes to self-confidence which is critical for gaining mathematics proficiency.

In addition to the many potential PBL math applications, the project report provides another opportunity to enhance math learning. The final product may be measured, or otherwise quantified. Students employ charts and graphs as well as photographs and sketches. Summaries may include financial data. Explaining computation provides additional opportunities for presenters and observers to learn math.

When one of the authors employed PBL during instruction, she heard many positive comments, including the three recorded below:

- “If we were doing another subject I would like to do it in groups.”
- “When you research it yourself, you won’t ever forget it.”
- “We don’t sound like the same students you asked to study science, do we?”

Indeed they did not sound like the same students. Students who originally did not want to work on projects and were very hesitant to study science demonstrated an increased interest almost daily.

Instructors change roles during PBL, serving as facilitators rather than deliverers of knowledge. During project-based instruction, they guide learning opportunities that help students take ownership of their learning. Sharing with peers allows students to teach information that ultimately becomes part of their knowledge base. According to Wrigley (1998),

Projects require that teachers get to know their learners’ interests. Teachers must listen for what has been called the teachable moment, that point in a discussion when learners become excited about a topic, and start asking questions such as, Why is x happening and what can we do about it. Facilitating project-based learning requires the kind of leadership skills that allow teachers to help a group of
learners to move in the direction that they want to go, pointing out potential pitfalls or making suggestions without getting defensive when students decide they like their own ideas better. (p. 5)

Benefits

When learners engage in projects that require budgets, they frequently spend time on calculations and time lines, gaining experience in practical math used in business and household management. If time-on-task counts, and many basic skills proponents believe it does, we can expect project work to lead to a deeper understanding of what it takes to apply math to real-life problems (Croll & Moses, 1988 and Wrigley, 1998).

A website entitled, “Project-based Learning with Multimedia,” summarizes the major benefits of PBL:

- PBL motivates students by engaging them in their own learning. PBL provides opportunities for students to pursue their own interests and questions and make decisions about how to find answers and solve problems.
- PBL provides opportunity for interdisciplinary learning. Students apply and integrate the content of different subject areas at authentic moments in the production process, instead of in isolation or in an artificial setting.
- PBL helps make learning relevant and useful to students by establishing connection to life outside the classroom, addressing real world concerns, and developing real world skills. Many of the skills learned through PBL are those desired by today’s employer, including the ability to work well with others, make thoughtful decisions, take initiative, and solve complex problems.
To these benefits, Kraft (2003) adds that PBL allows for different learning styles, provides a risk-free environment, encourages use of higher order thinking skills, utilizes hands-on approach, supports ownership of learning, and utilizes real-time data.

Railsback (2002) emphasizes that preparation through PBL for the workplace improves problem solving skills. She also says that PBL enables students to see connections between disciplines, allows them to use individual learning strengths, and provides a practical real-world approach to learning technology.

PBL integrates learning. Students simultaneously enhance planning and communicating skills, further preparing them for success in the workforce. The Buck Institute for Education Project Based Learning Handbook (2002) states,

Once teachers feel comfortable with PBL, they usually find teaching with projects to be more fulfilling and more enjoyable. PBL is a way of working with students as they discover themselves and the world, and that brings job satisfaction. (p. 9)

According to Ngeow (1998), Dewey (1938) states,

One of the philosophies of education is not to learn merely to acquire information but rather to bring that learning to bear upon our everyday actions and behaviors. Consistent with this goal, we would argue that collaborative learning in the classroom should prepare learners for the kind of team work and critical interchange that they will need to be effective participants in their communities and workplaces in the future. (p. 2)
Chapter 8

Using the Calculator

Dianne B. Barber

The joy is in the process.
Henry Adams
Introduction

The purpose of this chapter is to provide an easy to understand guide for learning to use a scientific calculator. The Casio fx-260 calculator has been chosen as the model since it is the official calculator for the GED test.

Trainers will find the content useful for planning professional development workshops or for individual professional development. Instructors may use this chapter to enhance their skills or use it as a classroom teaching tool. It is written to be effective for use in large groups, small groups, one-on-one or independently.

This chapter discusses and demonstrates the functions most often used in Adult Basic Skills mathematics instruction. It starts with basic functions used in beginning math and goes through the higher level functions used in Adult High School and GED mathematics. However, this chapter does not cover all the functions on the calculator.

This chapter is divided into lesson and practice sections for each function introduced. Trainers and instructors working with multi-level groups may find it useful to assign lessons and practice based on participant and/or student needs. An answer key for all practice problems is included at the end of the chapter.

Scientific calculators are very powerful and perform more functions than discussed in this chapter. Most scientific calculators have memory, statistical, trigonometric, and logarithmic functions. One of the best ways to learn to use the calculator efficiently and effectively is to experiment—try a key and see what it does.

This chapter has been adapted from the calculator chapter published in the ABSPD GED 2002 Training Manual Series (Knight, Barber, & Barber, 2002). It is updated with additional practice as requested by many instructors who have been using the former version.

For those who prefer a more multi-media approach to learning to use a calculator, refer to the ABSPD CD-Rom *Using the Scientific Calculator* which complements this chapter.
The Calculator

As emphasis continues to be placed on lifelong learning, the skills developed for using a scientific calculator are stepping stones for skills required in higher education and application to workplace technology. Many adults have not been exposed to scientific calculators. Without instruction, most Adult Basic Skills students are not able to use the calculator effectively. This chapter is to help students learn to effectively use a scientific calculator.

The information contained in this chapter is to be used as a supplement to mathematics instruction. This chapter does not teach mathematical concepts but addresses how to use the calculator as a tool. It covers a large majority of the mathematical functions that students may need from beginning level math through Adult High School and GED math.

The GED Testing Service of the American Council on Education adopted the Casio fx-260 Solar Scientific Calculator as the official calculator for use on the GED Mathematics Test. It is the calculator referenced throughout this chapter. The Casio fx-260 scientific calculator is similar to other inexpensive scientific calculators. Most calculators have their function keys arranged in a similar fashion, so it should not be difficult to use this chapter to learn to use other scientific calculators.

**Calculator Instructions.** Calculators usually come with instructions that explain the functions. Keep them; they may prove useful. The instructions may help you figure out how your particular calculator works or how to use functions not explained in this chapter. If you misplace the instructions, order another set from the manufacturer.
**Protective Cover.** The fx-260 comes with a plastic cover that protects the keys. To use the calculator, remove the cover by sliding it towards the top then sliding it onto the back. When not in use, it is important to use the cover to protect the keys.

**Solar Power.** Solar powered calculators, such as the Casio fx-260, do not require a battery to operate. They use light as their power source. With a solar powered calculator, a dead battery in the middle of a test or homework assignment is not a concern. However, if it does not have battery backup, it means there must be ample light for the calculator to work properly. If the calculator display is dim or does not seem to be doing calculations properly, place it in direct light to correct the problem.

**Small Yet Powerful.** The fx-260 is really quite powerful, especially considering its small size and inexpensive cost. It has 38 keys. Almost every key performs two functions: one printed on each key in white and another printed above each key in gold. The shift key allows access to the functions printed in gold.

**The "SHIFT" Key.** This key is located in the upper left corner of the keypad. It is the solid black key with the word "SHIFT" written above it. This key allows you to "gain access" to the functions printed in gold above each of the keys. To perform the operation printed on the key in white, just press the key. However, to perform the function printed above the key in gold, first press and release the "SHIFT" key. The word "SHIFT" will appear in the upper left-hand corner of the screen, but the number does not change. When the function key is pressed, the word "SHIFT" disappears and the answer appears on the display. This function will be used often as you continue learning to use the calculator.

**The "MODE" Key.** This key is the second key in the first row and changes the "mode" of the calculator. However, ALL calculations for the GED are in the DEG mode. The DEG mode is the computational mode of the fx-260. If in further studies of mathematics it is necessary to change the mode,
there is a guide below the display window for the different modes. For instance, to use the calculator for statistical data, use the "SD" mode. Remember, " DEG " should appear in the top center of the display with a "0." on the right side of the display.

**Calculators Require Strong Math Skills**

Calculated require you to be strong in mathematical concepts and mental math skills. You must decide if the results obtained are reasonable. The calculator is only as accurate as the person entering the data. It can compute; it cannot think. Not only do calculators not think, they have no problem solving skills. The calculator does all the computations, but you do all the thinking and problem solving. **If you put garbage in, you get garbage out.**

Since you must do the thinking and problem solving, you need to thoroughly understand the problems. If not, the calculator only helps you calculate the wrong answer quicker. However, since the calculator does the long and tedious calculations, you are free to sharpen your thinking and problem solving skills.

To learn to use the new keys on the calculator, practice with examples to which you know the answers. By doing so, you know the calculator is being used correctly.

The first time working through this chapter you probably will not remember how to use all the keys. Make notes of any discoveries in the pages’ margins. Also, if there is a question about how a key works, seek clarification.
Lesson 1: Clearing and Correcting Keys

**The ON Key.** To use the calculator, press the "ON" key. The ON key is the last key in the first row. This key completely clears the display, the memory, and all pending operations. It also changes the "Mode" back to the computational mode (DEG). Pressing this key each time you begin to use the calculator insures that everything is cleared from the last time the calculator was used.

**The AC Key.** The all clear key is useful for clearing operations and problems. It is one of the two red keys. This key clears all pending operations but retains numbers stored in memory as well as the mode setting. Pressing the AC key prior to each new problem clears the last problem.

**The C Key.** There is another red key next to the all clear key; it is the clear key. This key clears only the last number entered. It retains other parts of the problem, whereas the all clear key clears the entire problem. Use the clear key to clear only a number punched in error.

For example: To compute 250 + 456, if 250 + 123 was punched in, correct the error by punching the C key, which removes "123." Then enter "456" and press the = key to arrive at the correct answer.

**The Delete Key.** Another key that is handy for correcting errors is the delete key. This is the second key from the left on the third row from the top. This key works similarly to the "backspace key" on a typewriter or computer; it clears the digit(s) on the display starting with the ones place. Each time the delete key is pressed, it deletes one digit of the number showing in the display, thus allowing correction of an entry without reentering the entire number.
**It's Your Turn**

Use the calculator to compute the answers for the following.

<table>
<thead>
<tr>
<th>To Do This</th>
<th>Key(s) to Press</th>
<th>Display Shows</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turn the calculator on</td>
<td>ON</td>
<td>0.</td>
</tr>
<tr>
<td>Enter 2467</td>
<td>2467</td>
<td>2467.</td>
</tr>
<tr>
<td>Change to 2468, i.e., delete the ones digit and change it to an 8</td>
<td>8</td>
<td>2468.</td>
</tr>
<tr>
<td>Add 357</td>
<td>+ 357</td>
<td>357.</td>
</tr>
<tr>
<td>Oops! I meant add 579; i.e., clear the entry and add 579</td>
<td>C 579</td>
<td>579.</td>
</tr>
<tr>
<td>Oops! I meant subtract 465, i.e., clear the entry and subtract 465</td>
<td>C - 465</td>
<td>465.</td>
</tr>
<tr>
<td>Calculate the result</td>
<td>=</td>
<td>2003.</td>
</tr>
<tr>
<td>Clear the display</td>
<td>AC</td>
<td>0.</td>
</tr>
</tbody>
</table>
**Practice 1: Clearing and Correcting**

<table>
<thead>
<tr>
<th>Example 1:</th>
<th>Display Shows</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enter 13.50, add 6.50</td>
<td></td>
</tr>
<tr>
<td>Change 6.50 to 7.20</td>
<td></td>
</tr>
<tr>
<td>Instead of adding 7.20 subtract 7.20</td>
<td></td>
</tr>
<tr>
<td>Calculate the result</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Example 2:</th>
<th>Display Shows</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enter 3457 and change to 3789</td>
<td></td>
</tr>
<tr>
<td>Then add 126</td>
<td></td>
</tr>
<tr>
<td>Clear 126 and change to 260</td>
<td></td>
</tr>
<tr>
<td>Clear 260 and change to subtract 260</td>
<td></td>
</tr>
<tr>
<td>Calculate the result</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Example 3:</th>
<th>Display Shows</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enter $254.88 plus $97.99 minus $79.94</td>
<td></td>
</tr>
<tr>
<td>Change $79.94 to $79.99</td>
<td></td>
</tr>
<tr>
<td>Clear $79.99 and add $79.99</td>
<td></td>
</tr>
<tr>
<td>Calculate the result</td>
<td></td>
</tr>
</tbody>
</table>
Lesson 2: Number and Basic Operation Keys

The majority of the computations done on calculators in today's society are basic calculations using the four basic operations of addition, subtraction, multiplication, and division.

addition \[+\]  
subtraction \[−\]  
multiplication \[×\]  
division \[÷\]

Locate the basic operation keys on the calculator. Also look at how the numeric keys, the digits 0-9, are arranged. Now locate the decimal and equal keys.

decimal \[\cdot\]  
equal \[=\]

Always end problems by pressing the equal key.

It's Your Turn

Just for fun and to be sure you know how to use the basic operation, numeric digit (0-9), and decimal keys, complete the cross-number puzzles on the following pages.
# Practice 2.1: Addition

|   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 1 |   | 2 |   |   | 3 |   |   | 4 |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 5 |   | 6 |   | 7 |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 8 |   | 9 |   |   | 10|   | 11|   | 12|   | 13|   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 15| 16| 17| 18| 19| 20|   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |

### Across

1. 7 + 8
2. 36 + 16
3. 2,536 + 4,891
4. 756,123 + 7,096,022
5. 87 + 206
6. 300 + 16
7. 30 + 51
8. 802,040 + 50,105
9. 9,080 + 3,094
10. 762 + 3,094
11. 59 + 63
12. 3,408 + 4,903
13. 52,000 + 4,671
14. 94 + 49
15. 1,297 + 8,406
16. 35 + 24

### Down

2. 36 + 16
4. 756,123 + 7,096,022
6. 300 + 16
7. 802,040 + 50,105
9. 3,111 + 20
11. 3,232 + 1,835
13. 897 + 1,242
16. 36 + 33
17. 19 + 51
18. 5 + 8
Practice 2.2: Subtraction

Across
1. 523 - 478
2. 98 - 39
3. 6,019 – 2,324
4. 152 - 94
5. 1,253 - 351
6. 900 - 684
7. 11,439 – 9,731
8. 1,141 - 283
9. 4,081 – 1,245
10. 461 - 87
11. 1,005 - 951
12. 1,363 - 872
13. 1,641 - 852
14. 81,730 – 75,310

Down
2. 98 - 39
4. 152 - 94
6. 900 - 684
8. 1,141 - 283
10. 461 - 87
12. 1,363 - 872
Practice 2.3: Multiplication

Across

1. 14 x 4
2. 13 x 5
3. 623 x 3
4. 153,083 x 6
5. 5 x 1
6. 29 x 18
7. 4 x 39
8. 1,688 x 6
9. 36 x 20
10. 89 x 61
11. 180 x 83
12. 179 x 62
13. 94 x 30
14. 77 x 26
15. 1 x 26
16. 9,400 x 30

Down

1. 13 x 5
2. 153,083 x 6
3. 5 x 1
4. 21 x 10
5. 8 x 7
6. 4 x 39
7. 21 x 10
8. 29 x 100
9. 1,271 x 2
10. 269 x 90
11. 18,014 x 5
12. 3 x 4
13. 45 x 2
14. 137 x 6
Practice 2.4: Division

<table>
<thead>
<tr>
<th>Across</th>
<th>Down</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. 865 ÷ 5</td>
<td>2. 15,690 ÷ 2</td>
</tr>
<tr>
<td>3. 7,506 ÷ 18</td>
<td>4. 5,208 ÷ 7</td>
</tr>
<tr>
<td>5. 72 ÷ 12</td>
<td>5. 68,607 ÷ 99</td>
</tr>
<tr>
<td>6. 369 ÷ 9</td>
<td>8. 16,412 ÷ 2</td>
</tr>
<tr>
<td>7. 4,890 ÷ 10</td>
<td>9. 8,625 ÷ 15</td>
</tr>
<tr>
<td>9. 216 ÷ 4</td>
<td>12. 1,300 ÷ 100</td>
</tr>
<tr>
<td>10. 60,920 ÷ 40</td>
<td>13. 354 ÷ 6</td>
</tr>
<tr>
<td>11. 5,665 ÷ 11</td>
<td></td>
</tr>
<tr>
<td>14. 7,860 ÷ 3</td>
<td></td>
</tr>
<tr>
<td>15. 507 ÷ 13</td>
<td></td>
</tr>
</tbody>
</table>
Practice 2.5: Decimals

Across
1. 1.00 - .936
3. .3 x .9
5. 12.50 + 17.50
6. 2.4 x 3.1 x .05
7. .001 x 83 x 1,000
9. 12.8 ÷ 20.0
11. 345.6 + 54.4
12. .99 - .63
13. 420 x 2.1

Down
1. .2 x .3 x .5
2. 246.98 + 353.02
3. .373 - .1
4. .08 x 900
6. .3 x 1.28
8. .195 - .147
9. 3.04 x .2
10. .08 + .08
12. .288 ÷ .9
Practice 2.6: Basic Operations

Across

1. 85 + 96
3. 231 ÷ 7
5. 40 − 19
6. 1.5 × 180
7. 143.643 + 36.357
9. 937 − 868
11. 345.5 + 321.5
12. .005 × 8000
13. 1,213 − 319

Down

1. 72 ÷ 6
2. .81 × 1000
3. 1251 − 873
4. 100 × 300
6. 185.34 + 33.66
8. 111 × 6
9. 459,684 + 678
12. 987,654 − 987,610
Lesson 3: Change of Sign Key

The change of sign key is the first key in the third row. It is used to change the sign of a number. To make a number negative, use this key. For example, to enter a negative number such as -3, enter the number 3 and then press \( \text{+/-} \) to change the sign, thus making the number -3.

Many people make a common error by using the subtraction key to make a number negative. Even though this works most of the time, it does not work all the time. For this reason, it is best to get into the habit of using the change of sign key to make numbers negative.

It’s Your Turn

A calculator may not be necessary to do these problems, but working with easy problems to learn the keys builds confidence in using the calculator.

<table>
<thead>
<tr>
<th>To Do This</th>
<th>Enter</th>
<th>Display Shows</th>
</tr>
</thead>
<tbody>
<tr>
<td>-4 + -3</td>
<td>4 ( \text{+/-} ) + 3 ( \text{+/-} ) =</td>
<td>-7.</td>
</tr>
<tr>
<td>5 \times -20</td>
<td>5 ( \times ) 20 ( \text{+/-} ) =</td>
<td>-100.</td>
</tr>
<tr>
<td>-4.78 + 3.239</td>
<td>4.78 ( \text{+/-} ) + 3.239 =</td>
<td>-1.541.</td>
</tr>
<tr>
<td>426 \div -6</td>
<td>426 ( \div ) 6 ( \text{+/-} ) =</td>
<td>-71.</td>
</tr>
</tbody>
</table>
Include the sign of the answer with the first digit of each answer.

<table>
<thead>
<tr>
<th>Across</th>
<th>Down</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. (-58) + (-14)</td>
<td>1. (-123) x (6)</td>
</tr>
<tr>
<td>3. (-7) x (2) x (-6) x (10)</td>
<td>2. (-109) + 9 - (-10)</td>
</tr>
<tr>
<td>5. (-19) x (-2) x (-29)</td>
<td>4. (-49) ÷ (-1)</td>
</tr>
<tr>
<td>8. (-48) ÷ (-2)</td>
<td>6. (-10) + (26)</td>
</tr>
<tr>
<td>10. (-100) - (-25)</td>
<td>7. (-8) x (-3)</td>
</tr>
<tr>
<td>12. (-12) + (27)</td>
<td>9. (-71) x (-6)</td>
</tr>
<tr>
<td>13. (-216) x 0</td>
<td>11. (-416) + 916</td>
</tr>
<tr>
<td>15. (-.8) x .8 x 10 x (-10)</td>
<td>14. 200 - (-45)</td>
</tr>
<tr>
<td>16. (-1026) ÷ (3)</td>
<td>17. (-672) ÷ (-12)</td>
</tr>
<tr>
<td>19. 32 + 96 + (-68)</td>
<td>18. (-1) x (-1) x (-1)</td>
</tr>
</tbody>
</table>
Practice 3.2: Negative Numbers

Perform the indicated operations:

1. $-7.9 + 5.6$
2. $-8.1 - 3.5$
3. $-0.3 \times 4.2$
4. $-4.8 \div -0.6$

5. The following transactions were made at a bank drive thru window one afternoon:

<table>
<thead>
<tr>
<th>Transaction</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deposit</td>
<td>$1,259.84</td>
</tr>
<tr>
<td>Withdrawal</td>
<td>$120.00</td>
</tr>
<tr>
<td>Withdrawal</td>
<td>$2,819.00</td>
</tr>
<tr>
<td>Deposit</td>
<td>$946.83</td>
</tr>
<tr>
<td>Withdrawal</td>
<td>$250.00</td>
</tr>
</tbody>
</table>

What is the average amount for these transactions?

6. Find the average temperature for the week.

<table>
<thead>
<tr>
<th>Day</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sunday</td>
<td>42</td>
</tr>
<tr>
<td>Monday</td>
<td>28</td>
</tr>
<tr>
<td>Tuesday</td>
<td>15</td>
</tr>
<tr>
<td>Wednesday</td>
<td>9</td>
</tr>
<tr>
<td>Thursday</td>
<td>-10</td>
</tr>
<tr>
<td>Friday</td>
<td>-23</td>
</tr>
<tr>
<td>Saturday</td>
<td>-16</td>
</tr>
</tbody>
</table>

7. Find the change in temperature from Wednesday to Thursday and from Friday to Saturday.
Lesson 4: Order of Operations, Grouping Symbols, and Missing Multiplication Signs

**Order of Operations.** Remember the "order of operations?" The order of operations may have been learned using the mnemonic, "Please excuse my dear Aunt Sally." The first letter of each word is used to help you remember the correct order of operations when solving math problems. Calculations should always be completed in the following order:

1. Work within Parentheses (grouping symbols)
2. Exponents
3. Multiplication and Division in order of appearance from left to right
4. Addition and Subtraction in order of appearance from left to right

Most small and inexpensive scientific calculators do not have "order of operations" as a built-in feature, but the fx-260 does. When evaluating an expression that includes several operations, the fx-260 "knows" to compute exponents before multiplying or dividing and to multiply or divide before adding or subtracting. It also "knows" to perform operations within parentheses before performing operations outside parentheses.

You may think, "Great, I won't need to know order of operations since the calculator has it built in." WRONG, WRONG, WRONG! You still need to know order of operations and sometimes you may need to add parentheses so the calculator calculates using the correct order. Let's investigate how the built-in feature, order of operations, works by completing an example.

To compute $2 + 3 \times 4$, enter the expression into the calculator as written, $2 + 3 \times 4$, then press the $=$ key. The fx-260 will compute the correct answer, which is 14. However, many small and inexpensive calculators will compute $2 + 3$ and then multiply by 4 which results in an incorrect answer of 20.
As you are exposed to different calculators, notice if they have a built-in order of operations. Test to see if a calculator has built in order of operations by doing a computation similar to the one on the previous page. Anytime you test a feature or function, use examples for which the answer is known or that can easily be calculated using paper and pencil.

**Grouping Symbol Keys.** In the third row of keys on the calculator there are two grouping symbol (brackets and parentheses) keys:

- ![Left Grouping -- Open parentheses/bracket](image1)
- ![Right Grouping -- Close parentheses/bracket](image2)

On the calculator, grouping symbols always work in sets, i.e., every time you open a set you must also close the set. Use these keys to complete a computation that involves grouping symbols, parentheses, and/or brackets. Enter the grouping symbols as they are written in the problem. The calculator also allows the use of nested grouping symbols. Remember, when grouping symbols are used, they are used in pairs. Each time you open a set you must close the set.

**It's Your Turn**

Use the calculator to compute the answers for the following examples.

<table>
<thead>
<tr>
<th>To Do This</th>
<th>Enter</th>
<th>Display Shows</th>
</tr>
</thead>
<tbody>
<tr>
<td>(3+2)×4</td>
<td>[left grouping] 3 + 2 [right grouping] × 4 =</td>
<td>20.</td>
</tr>
<tr>
<td>40- (9+21)</td>
<td>40 - [left grouping] 9 + 21 [right grouping] =</td>
<td>10.</td>
</tr>
</tbody>
</table>
Sometimes it is necessary to "add" parentheses so the calculator correctly computes the answer. One example is working with complex fractions.

For instance, if there is a complex fraction such as \( \frac{7 + 13}{2 + 3} \), include parentheses around the numerator and around the denominator since the fraction bar acts as a grouping symbol. If doing this problem using mental math, follow these steps:

**Missing Multiplication Symbols.** Scientific calculators evaluate expressions involving parentheses; the calculator "knows" to evaluate what is inside the parentheses first. However, you must always "tell" the calculator what operation to perform. When there is a missing multiplication symbol, include the multiplication symbol when entering the expression.

For example, to compute \( 3(4 + 5) \) using mental math or with pencil and paper, add \( 4 + 5 \) and then multiply by 3. However, to compute this on the calculator, enter "3 x (4 + 5)=" which results in the correct answer of 27.

### It's Your Turn

Use the calculator to compute the answers for the following examples.

<table>
<thead>
<tr>
<th>To Do This</th>
<th>Enter</th>
<th>Display Shows</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \frac{7 + 13}{2 + 3} )</td>
<td>((3) 7 + 13 (---)) ÷ ((--- 2 + 3 (---)) =</td>
<td>4</td>
</tr>
<tr>
<td>( \frac{9 - 3}{3 + 3} )</td>
<td>((3) 9 - 3 (---)) ÷ ((--- 3 + 3 (---)) =</td>
<td>1</td>
</tr>
<tr>
<td>( 8(3+9) )</td>
<td>8 (--- 3 + 9 (---)) =</td>
<td>96</td>
</tr>
<tr>
<td>( 2(4+6) )</td>
<td>2 (--- 4 + 6 (---)) =</td>
<td>20</td>
</tr>
</tbody>
</table>

ALWAYS THINK about what you are doing. YOU must enter correct information for the calculator to compute the correct answer.
Practice 4: Order of Operations, Grouping Symbols, and Missing Multiplication Signs

Use the calculator to compute the answers for the following examples.

<table>
<thead>
<tr>
<th>Record Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. 3(5 – 2) + 6×1</td>
</tr>
<tr>
<td>2. 3 + 12 – 5 × 2</td>
</tr>
<tr>
<td>3. (1 + 9) × (7 – 3)</td>
</tr>
<tr>
<td>4. ( \frac{20 + 30}{5} \times 5 )</td>
</tr>
<tr>
<td>5. 2(4 + 6) – 3(7 – 5)</td>
</tr>
</tbody>
</table>

6. Aaron budgeted $3,600 for rent, $780 for utilities, and $1,800 for food for a year. How much is his monthly budget for these expenses?

7. The Voss family is building a swimming pool that will be 32 feet by 18 feet. They want a fence around the pool that will be built 7 feet from each side of the pool. How much fencing will be required for the pool?
8. A car rental agency is advertising a full size car for $14.95 per day plus $0.29 per mile. If you rent this car for 2 days, how many whole miles can be driven on a $100 budget?

9. Rebecca owns a catering business and has been asked to quote a price per person for catering fruit salad at an afternoon reception for 20 people.

a. Use Rebecca's recipe and the prices given to calculate the cost per person. Remember to charge the 7% sales tax on purchases.

b. What additional amount should Rebecca charge per person if she hopes to receive a total of $90 for the catering job?

c. How much total profit will she make on this job?

Rebecca's Fruit Salad

- 2 lbs. grapes, halved
- 3 lbs. of watermelon, cubed
- 1 lb. fresh blueberries
- 1.25 lbs. of nectarines or mangos, sliced
- 1 6 ounce can frozen fruit juice concentrate, thawed

Combine ingredients, and serve chilled.

Yields: Ten servings.

Rebecca buys the fruit juice concentrate in bulk. It comes frozen in 1-ounce cubes. She gets 64 cubes for $2.56.
Lesson 5: The Percent Key

The percent function is the second function of the equals key. To compute percents using the percent function you need to press \( \% \) and then the \( = \) key. Remember, to use one of the functions printed in "gold," first press \( \text{shift} \) then press the key below the function to be used.

Adults work with percents when shopping, opening a savings account, or borrowing money. The percent key greatly reduces the time required to calculate percents, but to learn to use this key efficiently, you need a thorough understanding of how percents work and be able to correctly complete percent problems with pencil and paper.

To take "10% of 96" when using pencil and paper, there are two choices for setting up the problem:

Choice 1: \( 10\% \times 96 \)  
or  
Choice 2: \( 96 \times 10\% \)

However, when using the percent function on the calculator, always "arrange" the problem so that the "\%" is entered last as in choice 2 above. Try it. Find 10% of 96. Was the answer 9.6? If not, try again.

Percent Increase/Percent Decrease: The percent function can also be used to calculate percent increases or percent decreases. Calculate the percent, then press \( + \) to calculate a percent increase. To calculate a percent decrease, press \( - \) after calculating the percent. Use the calculator to work through the following example.

Example 1: A television that regularly sells for $400 is on sale for 25% off. Find the sale price, the sales tax (7%), and the total cost of the television.
Step 1: Find the sale price.
To calculate the sale price enter the following:

\[ 400 \times 25 \]  
This calculates the discount ($100). Press \(-\) to calculate the sale price ($300).

Step 2: Find the sales tax.
To calculate the sales tax enter the following:

\[ 300 \times 7 \]  
The sales tax is $21.00.

Step 3: Find the total cost.
Press \(+\) at the end of step 2 to increase the sale price by 7% resulting in a total cost of $321.00.

It's Your Turn

Use the calculator to compute the answers for the following.

<table>
<thead>
<tr>
<th>To Do This</th>
<th>Enter</th>
<th>Display Shows</th>
</tr>
</thead>
<tbody>
<tr>
<td>Find 25% of 180.</td>
<td>180 × 25(\text{SHIFT} ) (=)</td>
<td>45.</td>
</tr>
<tr>
<td>Increase 180 by 25%.</td>
<td>180 × 25 (\text{SHIFT} ) (=) (+)</td>
<td>225.</td>
</tr>
<tr>
<td>A store is having a 40% off sale on walking shoes. If the pair you really like has a regular price of $60, what is the sale price?</td>
<td>60 × 40 (\text{SHIFT} ) (=) (-)</td>
<td>36.</td>
</tr>
<tr>
<td>What number is 60% of 95?</td>
<td>95 × 60 (\text{SHIFT} ) (=)</td>
<td>57.</td>
</tr>
<tr>
<td>24 is 4% of what number?</td>
<td>24 ÷ 4 (\text{SHIFT} ) (=)</td>
<td>600.</td>
</tr>
</tbody>
</table>
Practice 5.1: Basic Percents

<table>
<thead>
<tr>
<th>Across</th>
<th>Down</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. .4% of 5,000</td>
<td>1. 8% of 300</td>
</tr>
<tr>
<td>2. 96% of 900</td>
<td>3. 300% of 141</td>
</tr>
<tr>
<td>5. 5% of 500</td>
<td>4. 23% of 14,000</td>
</tr>
<tr>
<td>6. 4% of 300</td>
<td>6. 25% of 780</td>
</tr>
<tr>
<td>7. 37.5% of 88</td>
<td>7. 12.5% of 2904</td>
</tr>
<tr>
<td>8. 20% of 3960</td>
<td></td>
</tr>
<tr>
<td>9. 40% of 125</td>
<td></td>
</tr>
<tr>
<td>10. 1% of 34,000</td>
<td></td>
</tr>
</tbody>
</table>
Practice 5.2: More Percents

1. In a recent survey, 61 out of 300 drivers responded that they do not exceed the speed limit. What percent of the drivers exceed the speed limit?

2. A real estate agent earns 6% commission. If she sells a house for $135,000, how much commission does she earn?

3. The bookstore is advertising a 10% discount on calculators that have a regular price of $9.95 each. The discount increases to 15% if purchased by the case. One case contains 6 calculators. The sales tax is 7%. Use this information to fill in the chart.

<table>
<thead>
<tr>
<th></th>
<th>One</th>
<th>One Dozen</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Regular Price</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Discount</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Sale Price</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Sales Tax</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total Cost</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
4. Use the information in the chart to solve the following problems. Chris plans to buy 2 pairs of pants and 3 shirts at the sale price.

<table>
<thead>
<tr>
<th>Item</th>
<th>Regular Price</th>
<th>Sale Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shirts</td>
<td>$29.95</td>
<td>$23.96</td>
</tr>
<tr>
<td>Pants</td>
<td>$49.96</td>
<td>$37.47</td>
</tr>
<tr>
<td>Jackets</td>
<td>$89.95</td>
<td>$53.97</td>
</tr>
</tbody>
</table>

How much will he save by buying the clothing at the sale price instead of the regular price?

If sales tax is 7%, how much sales tax will he pay?

What can he expect to pay total, i.e. including sales tax?

What is the percent discount for the pants?

What is the percent discount for the shirts?

What is the percent discount for the jackets?
Lesson 6: The Fraction Key

Is finding common denominators and reducing fractions difficult? Is there an easier way? The fraction functions on the Casio fx-260 make operations with fractions as easy as operations with whole numbers. These functions allow you to add and subtract fractions with ease; i.e., you do not have to find a common denominator. The same goes for division, i.e., no more “flip and multiply.” The calculator displays all results in reduced form. If all you need to do is reduce a fraction, the calculator will do that for you too.

The fraction key, , is the first key in the second row; it is used to enter fractions. Another fraction function is printed in gold right above the key. These functions are used to convert fractions to decimals or mixed numbers to fractions.

When entering fractions on the calculator the fraction is not displayed as you might expect. For example, a mixed number such as will be displayed as

When reading the display, read from left to right. If there are three parts then you know it is a mixed number with the first number being the whole part, the second number being the numerator and the last number being the denominator. If only two numbers are showing, such as , then the first number is the numerator and the last number is the denominator, i.e., .
To Enter a Mixed Number

Enter the "whole number part," press the fraction key, enter the numerator, press the fraction key, and then enter the denominator. **Enter other fractions the same way.** For example:

<table>
<thead>
<tr>
<th>To Enter Fractions</th>
<th>Enter</th>
<th>Display Shows</th>
</tr>
</thead>
<tbody>
<tr>
<td>$3 \frac{4}{5}$</td>
<td>$3 \frac{4}{5}$</td>
<td>$3 \frac{4}{5}$</td>
</tr>
<tr>
<td>$\frac{7}{8}$</td>
<td>$\frac{7}{8}$</td>
<td>$\frac{7}{8}$</td>
</tr>
</tbody>
</table>

Note, do not press the fraction key after entering the last part of a mixed number or fraction.

To Reduce a Fraction

Enter the mixed number or fraction as described above and press $=$. You try it.

<table>
<thead>
<tr>
<th>To Reduce Fractions</th>
<th>Enter</th>
<th>Display Shows</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\frac{4}{6}$</td>
<td>$\frac{4}{6}$</td>
<td>$\frac{2}{3}$</td>
</tr>
<tr>
<td>$\frac{5}{6}$</td>
<td>$\frac{5}{6}$</td>
<td>$\frac{5}{3}$</td>
</tr>
<tr>
<td>$\frac{20}{3}$</td>
<td>$\frac{20}{3}$</td>
<td>$\frac{6}{2}$</td>
</tr>
<tr>
<td>$\frac{32}{4}$</td>
<td>$\frac{32}{4}$</td>
<td>$8$</td>
</tr>
</tbody>
</table>
To Change a Fraction to a Decimal

After entering the mixed number or fraction, press \( = \) and then press \( \frac{\text{a}}{\text{b}} \); the display shows the decimal. By pressing \( \frac{\text{a}}{\text{b}} \) again the display changes back to the mixed number. You try it.

<table>
<thead>
<tr>
<th>To Change Fractions to Decimals</th>
<th>Enter</th>
<th>Display Shows</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \frac{4}{5} )</td>
<td>4 ( \frac{\text{a}}{\text{b}} ) 5 ( = ) ( \frac{\text{a}}{\text{b}} )</td>
<td>.8</td>
</tr>
<tr>
<td>( \frac{56}{8} )</td>
<td>5 ( \frac{\text{a}}{\text{b}} ) 6 ( \frac{\text{a}}{\text{b}} ) 8 ( = ) ( \frac{\text{a}}{\text{b}} )</td>
<td>5.75</td>
</tr>
<tr>
<td>( \frac{20}{3} )</td>
<td>20 ( \frac{\text{a}}{\text{b}} ) 3 ( = ) ( \frac{\text{a}}{\text{b}} )</td>
<td>6.666666667</td>
</tr>
<tr>
<td>( \frac{32}{4} )</td>
<td>32 ( \frac{\text{a}}{\text{b}} ) 4 ( = ) ( \frac{\text{a}}{\text{b}} )</td>
<td>8</td>
</tr>
</tbody>
</table>

To Change a Mixed Number to an Improper Fraction

First enter the mixed number using the \( \frac{\text{a}}{\text{b}} \) key and then press \( \frac{\text{a}}{\text{b}} \) and the \( \text{SHIFT} \) function to change the mixed number to an improper fraction. You try it.

<table>
<thead>
<tr>
<th>To Change Mixed Numbers to Fractions</th>
<th>Enter</th>
<th>Display Shows</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \frac{34}{5} )</td>
<td>3 ( \frac{\text{a}}{\text{b}} ) 4 ( \frac{\text{a}}{\text{b}} ) ( \text{SHIFT} ) ( \frac{\text{a}}{\text{b}} )</td>
<td>19__</td>
</tr>
<tr>
<td>( \frac{56}{8} )</td>
<td>5 ( \frac{\text{a}}{\text{b}} ) 6 ( \frac{\text{a}}{\text{b}} ) 8 ( \text{SHIFT} ) ( \frac{\text{a}}{\text{b}} )</td>
<td>23 __</td>
</tr>
</tbody>
</table>
To Add, Subtract, Multiply, or Divide Fractions

To perform basic operations, just enter each fraction using the key and continue just as you would with any other type problem. You try it.

<table>
<thead>
<tr>
<th>To Do This</th>
<th>Enter</th>
<th>Display Shows</th>
</tr>
</thead>
<tbody>
<tr>
<td>(7\frac{1}{5} + 1\frac{1}{3})</td>
<td>(7 \div 1 \text{ a b c } 5 \div 1 \text{ a b c } 1 \text{ a b c } 3 =)</td>
<td>5_2_5.</td>
</tr>
<tr>
<td>(6\frac{3}{4} + 1\frac{1}{2})</td>
<td>(6 \text{ a b c } 3 \text{ a b c } 4 + 1 \text{ a b c } 2 =)</td>
<td>7_1_4.</td>
</tr>
<tr>
<td>(\frac{5}{6} - \frac{1}{12})</td>
<td>(5 \text{ a b c } 6 \div 1 \text{ a b c } 12 =)</td>
<td>3_4.</td>
</tr>
</tbody>
</table>

Most adults like using the calculator when working with fractions. However, learning to properly use the fraction key takes more practice than some of the other keys. Complete the practice problems on the following pages to sharpen your skill using the calculator as a tool.

It's Your Turn

Use the calculator to find the answers to the cross-number puzzle and the solutions to the word problems on the following pages.
Each fractional part; i.e., whole number, numerator, and denominator, fills one square. If there are only two squares and you get a mixed number answer, change it to an improper fraction.

Across

1. $\frac{5}{2} - \frac{4}{3}$
2. $\frac{11}{21} + \frac{1}{3}$
3. $\frac{3}{8} + \frac{1}{4} + \frac{3}{2}$
4. $1 - \frac{2}{9}$
5. $\frac{2}{5} + 1 \frac{9}{10}$
6. $\frac{1}{4} + \frac{1}{2}$
7. $\frac{3}{45} + \frac{4}{18}$
8. $\frac{1}{3} \times \frac{2}{3}$
9. $\frac{1}{5} \times 2 \frac{1}{2}$
10. $\frac{4}{5} + \frac{4}{3}$
11. $7 \frac{1}{5} + 1 \frac{1}{3}$
12. $\frac{6}{8} - 5 \frac{1}{2}$

Down

1. $\frac{11}{21} + \frac{1}{3}$
2. $1 - \frac{2}{9}$
3. $\frac{3}{4} + \frac{1}{2}$
4. $\frac{1}{3} \times \frac{2}{3}$
5. $\frac{2}{5} + 1 \frac{9}{10}$
6. $\frac{3}{45} + \frac{4}{18}$
7. $7 \frac{1}{5} + 1 \frac{1}{3}$
8. $\frac{1}{5} \times 2 \frac{1}{2}$
9. $\frac{6}{8} - 5 \frac{1}{2}$
10. $\frac{5}{2} - \frac{4}{3}$
11. $\frac{3}{8} + \frac{1}{4} + \frac{3}{2}$
12. $\frac{2}{5} + 1 \frac{9}{10}$
13. $\frac{6}{8} - 5 \frac{1}{2}$
Practice 6.2: More Fractions

1. Cindy is working on a craft project which requires the following lengths of ribbon: 2 pieces $2\frac{3}{4}$ feet long, 3 pieces $1\frac{1}{8}$ feet long, and 1 piece $3\frac{1}{2}$ feet long. The ribbon sells for $1.19 per yard.

   a. How many yards of ribbon does she need?

   b. What is the total cost of the ribbon including 7% sales tax?

2. Calculate the perimeter for the scale drawings below.
3. The carpet shop is running a "Buy one, get one free" sale on all the carpet and padding they have in stock. The carpet chosen for the bedroom (scale drawing below) sells for $1.98 per square foot when not on sale. The regular price of the padding is $4.95 per square yard.

![Scale drawing of a bedroom with dimensions: 12 3/8 feet by 16 1/2 feet by 2 3/8 feet by 9 1/4 feet.]

a. How many square yards of carpet will it take to carpet the bedroom? Give answer as the number of “whole” yards that must be purchased.

b. How much will the carpet cost for the bedroom? Be sure to include the 7% sales tax. Round the answer up to the nearest dollar.
Lesson 7: Exponents

Exponents are a shorthand way of writing repeated multiplication. The fx-260 has three exponential functions that are often used. They are as follows:

- This key is used to *square* a number (or raise a number to the second power). This key is the third key on the first row.

- The second function of this key is used to *cube* a number (or raise a number to the third power). This function is above the second key on the third row.

- This key is used to raise a number, $x$, to any power, $y$. This key is the next to last key on the third row.

These functions are extremely useful when working with geometric shapes and problem solving. The calculator has other exponential functions, however those functions are used when working with negative exponents and logarithms.

As you work, notice how exponents are expressed in different ways. For example:

<table>
<thead>
<tr>
<th>Exponent</th>
<th>Ways to Express</th>
</tr>
</thead>
<tbody>
<tr>
<td>$4^2$</td>
<td><em>four to the second power</em>&lt;br&gt;<em>four squared</em>&lt;br&gt;<em>four times four</em></td>
</tr>
<tr>
<td>$5^3$</td>
<td><em>five to the third power</em>&lt;br&gt;<em>five cubed</em>&lt;br&gt;<em>five times five times five</em></td>
</tr>
<tr>
<td>$6^4$</td>
<td><em>six to the fourth power</em>&lt;br&gt;<em>six times six times six times six</em></td>
</tr>
<tr>
<td>$x^5$</td>
<td><em>x to the fifth power</em>&lt;br&gt;<em>x times x times x times x times x</em></td>
</tr>
</tbody>
</table>
It’s Your Turn

Use the calculator to compute the answers for the following examples.

<table>
<thead>
<tr>
<th>To Do This</th>
<th>Enter</th>
<th>Display Shows</th>
</tr>
</thead>
<tbody>
<tr>
<td>$6^2$</td>
<td>6</td>
<td>36.</td>
</tr>
<tr>
<td>$5^3$</td>
<td>5</td>
<td>125.</td>
</tr>
<tr>
<td>$2^5$</td>
<td>2 5</td>
<td>32.</td>
</tr>
<tr>
<td>$3.5^2$</td>
<td>3.5</td>
<td>12.25</td>
</tr>
<tr>
<td>$5^4$</td>
<td>5 4</td>
<td>625.</td>
</tr>
<tr>
<td>$2^3 \cdot 3^2$</td>
<td>2 3 3</td>
<td>72.</td>
</tr>
</tbody>
</table>
## Practice 7.1: Exponents

Use the exponent keys on the calculator to simplify each of the following:

<table>
<thead>
<tr>
<th>Square</th>
<th>Answer</th>
<th>Cube</th>
<th>Answer</th>
<th>Mixed</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. $1^2$</td>
<td>______</td>
<td>$1^3$</td>
<td>______</td>
<td>$1^{10}$</td>
<td>______</td>
</tr>
<tr>
<td>2. $2^2$</td>
<td>______</td>
<td>$2^3$</td>
<td>______</td>
<td>$2^4$</td>
<td>______</td>
</tr>
<tr>
<td>3. $3^2$</td>
<td>______</td>
<td>$3^3$</td>
<td>______</td>
<td>$3^5$</td>
<td>______</td>
</tr>
<tr>
<td>4. $4^2$</td>
<td>______</td>
<td>$4^3$</td>
<td>______</td>
<td>$4^4$</td>
<td>______</td>
</tr>
<tr>
<td>5. $5^2$</td>
<td>______</td>
<td>$5^3$</td>
<td>______</td>
<td>$5^4$</td>
<td>______</td>
</tr>
<tr>
<td>6. $(-2)^2$</td>
<td>______</td>
<td>$(-2)^3$</td>
<td>______</td>
<td>$-2^2$</td>
<td>______</td>
</tr>
<tr>
<td>7. $(-3)^2$</td>
<td>______</td>
<td>$(-3)^3$</td>
<td>______</td>
<td>$-3^3$</td>
<td>______</td>
</tr>
<tr>
<td>8. $(-4)^2$</td>
<td>______</td>
<td>$(-4)^3$</td>
<td>______</td>
<td>$-4^2$</td>
<td>______</td>
</tr>
<tr>
<td>9. $(-5)^2$</td>
<td>______</td>
<td>$(-5)^3$</td>
<td>______</td>
<td>$-5^3$</td>
<td>______</td>
</tr>
</tbody>
</table>

10. A positive number squared plus six squared equals one hundred. What is the number?

11. Four times a positive number squared minus that number squared is seventy-five. What is that number?
## Practice 7.2: More Exponents

### Across

1. $5^3$
2. $11^2$
3. $134 \times 10^0$
4. $7.4 \times 10^3$
5. $7^4$
6. $12^2 \times 10^2$
7. $6^2 + 3$
8. $n^2 = 900, n =$
9. $4^4$
10. $n^2 = 400, n =$

### Down

1. $2^7$
2. $8^3$
3. $3^3$
4. $12^2 \times 10^2$
5. $7^3$
6. $4^6$
7. $9^0$
8. $5^2$
9. $2^5$
Lesson 8: Roots and Radicals

The Casio fx-260 has two root keys. They are as follows:

Use the square root function to find the square root of a number. This function is the second function of the $x^2$ key. It is located above the third key on the first row. To use this function you will need to use the shift function.

Use the cube root function to find the cube root of a number. This function is the second function of the change of sign key. It is located above the first key in the third row. To use this function you will need to use the shift function.

It's Your Turn

Use the calculator to compute the answers for the following problems.

<table>
<thead>
<tr>
<th>To Do This</th>
<th>Enter</th>
<th>Display Shows</th>
</tr>
</thead>
<tbody>
<tr>
<td>Find the square root of 36</td>
<td>36 $\sqrt{}$</td>
<td>6.</td>
</tr>
<tr>
<td>Find the cube root of 27</td>
<td>27 $\sqrt[3]{3}$</td>
<td>3.</td>
</tr>
<tr>
<td>Simplify $\sqrt{64}$</td>
<td>64 $\sqrt{}$</td>
<td>8.</td>
</tr>
<tr>
<td>Simplify $\sqrt[3]{64}$</td>
<td>64 $\sqrt[3]{3}$</td>
<td>4.</td>
</tr>
</tbody>
</table>
Practice 8.1: Roots

Across
1. \( \sqrt{144} \)
2. \( \sqrt{729} \)
4. \( \sqrt{225} \)
5. \( \sqrt[3]{1331} \)
7. \( \sqrt{400} \)
8. \( \sqrt{2025} \)
10. \( \sqrt{900} \)
11. \( \sqrt{4096} \)
14. \( \sqrt{2401} \)
16. \( \sqrt{4225} \)
18. \( \sqrt[3]{2744} \)

Down
1. \( \sqrt{169} \)
2. \( \sqrt{625} \)
3. \( \sqrt{1681} \)
5. \( \sqrt{10000} \)
6. \( \sqrt{1156} \)
7. \( \sqrt{529} \)
9. \( \sqrt{3136} \)
12. \( \sqrt{2116} \)
13. \( \sqrt[3]{1728} \)
15. \( \sqrt{8281} \)
17. \( \sqrt{2809} \)
Practice 8.2: More Roots

1. Find the length of the hypotenuse of a right triangle whose legs have lengths of 3 centimeters and 4 centimeters.

2. Romeo is standing 20 feet away from the wall below Juliet's balcony. Juliet is on the balcony, 12 feet above the ground. How far apart are Romeo and Juliet?

3. Fernando frequently drives to a movie theatre in a nearby town. If he drives on the main roads, he must drive 6 miles east and then 8 miles north. There is a shorter route through the woods that runs directly from his house to the theatre. How many miles is the route that runs directly from his house to the theatre? How many miles shorter is this route?

Lesson 9: Pi

The Pi function is the second function of the middle key on the bottom row. Notice that \( \pi \) is not written in gold, therefore you do not need to use the shift key to use this function. The Pi function is most often used when working with geometric formulas for circles, cones and cylinders. For example, the Pi function is used to calculate the circumference or area of a circle and the volume or surface area of a cone or cylinder.

The key is used for computations when numbers are written in scientific notation and/or to change numbers written in scientific notation to standard notation. However, it does not work for negative exponents.

You try it. Use the calculator to compute the answers for the following problems.

<table>
<thead>
<tr>
<th>To Do This</th>
<th>Enter</th>
<th>Display Shows</th>
</tr>
</thead>
<tbody>
<tr>
<td>Find the value for Pi</td>
<td>EXP</td>
<td>3.1415…</td>
</tr>
<tr>
<td>Find the circumference of a circle with a</td>
<td>EXP</td>
<td>18.849…</td>
</tr>
<tr>
<td>diameter of 6 inches</td>
<td>( \times ) 6 =</td>
<td></td>
</tr>
<tr>
<td>Find the area of a circle with a 3 inch radius</td>
<td>EXP</td>
<td>28.274…</td>
</tr>
<tr>
<td></td>
<td>( \times ) 3 ( \times ) 3 =</td>
<td></td>
</tr>
<tr>
<td>Write 2.5 ( \times ) 10^3 in standard notation</td>
<td>2.5 ( \times ) 3 =</td>
<td>2500.</td>
</tr>
<tr>
<td>Find the value of ( (3 \times 10^3) + (4 \times 10^3) )</td>
<td>3 ( \times ) 2 ( + ) 4 ( \times ) 3 =</td>
<td>4300.</td>
</tr>
</tbody>
</table>
Practice 9: Pi and Scientific Notation

1. How many miles of rope are needed to wrap it around the Earth at the equator, if the radius of the Earth is 4000 miles.

2. A circular garden, 24 feet in diameter, has a 3-foot wide gravel walk around it. What is the approximate area of the walk in square feet? Round the answer to the nearest tenth. If edging is put between the walk and garden, how many feet would it require? Round the answer to the nearest tenth.

3. Find the amount of space occupied by a ball that has a diameter of 3 feet.

4. Find: \((5 \times 10^7)(9 \times 10^4)\)

5. The population of the world is approximately \(5.506 \times 10^9\). What is the population of the world in standard form?
# Answers for Practice Exercises

## Practice 1: Clearing and Correcting

### Example 1

<table>
<thead>
<tr>
<th>Example 1</th>
<th>6.50</th>
<th>7.20</th>
<th>7.20</th>
<th>6.30</th>
</tr>
</thead>
</table>

### Example 2

<table>
<thead>
<tr>
<th>Example 2</th>
<th>3789.</th>
<th>126.</th>
<th>260.</th>
<th>3529.</th>
</tr>
</thead>
</table>

### Example 3

<table>
<thead>
<tr>
<th>Example 3</th>
<th>79.94</th>
<th>79.99</th>
<th>79.99</th>
<th>432.86</th>
</tr>
</thead>
</table>

## Practice 2.1: Addition

### Practice 2.1: Addition

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5</td>
<td>7</td>
<td>4</td>
<td>2</td>
<td>7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>2</td>
<td>9</td>
<td>3</td>
<td></td>
<td></td>
<td>8</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>7</td>
<td>8</td>
<td>3</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
</tr>
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## Practice 2.2: Subtraction

### Practice 2.2: Subtraction

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- 148 -
Practice 2.3: Multiplication

Practice 2.4: Division
Practice 2.5: Decimals

Practice 2.6: Basic Operations
Practice 3.1: Negative Numbers

Practice 3.2: Negative Numbers

1. -2.3
2. -11.6
3. -.126
4. 8
5. -196.47
6. 6.43
7. -19º, +7º
Practice 4: Order of Operation ...

1. 15
2. 5
3. 40
4. 2
5. 14
6. $515
7. 128 ft.
8. 241 miles
9. $.69, $3.81, $76.31

Practice 5.1: Basic Percents

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</table>

Practice 5.2: More Percents

1. 80%
2. $8,100
3. Regular Price $9.95 $119.40
   Discount $.99 $17.91
   Sale Price $8.96 $101.49
   Sales Tax $.63 $7.10
   Total Cost $9.59 $108.59
4. $42.95, $10.28, $157.10, $25%, 20%, 40%
Practice 6.1: Fractions

<table>
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<td>8</td>
<td>2</td>
<td>3</td>
<td>9</td>
</tr>
</tbody>
</table>

Practice 6.2: More Fractions

1. 4 1/8 yards, $5.25
2. bedroom - 57.75 ft, kitchen/breakfast – 55.25 ft.
3. 21 yards, $201

Practice 7.1: Exponents

Square | Answer | Cube | Answer | Mixed | Answer
---|---|---|---|---|---
1. $1^2$ | 1 | $1^3$ | 1 | $1^{10}$ | 1
2. $2^2$ | 4 | $2^3$ | 8 | $2^4$ | 16
3. $3^2$ | 9 | $3^3$ | 27 | $3^5$ | 243
4. $4^2$ | 16 | $4^3$ | 64 | $4^4$ | 256
5. $5^2$ | 25 | $5^3$ | 125 | $5^4$ | 625
6. $(-2)^2$ | 4 | $(-2)^3$ | -8 | $(-2)^2$ | -4
7. $(-3)^2$ | 9 | $(-3)^3$ | -27 | $(-3)^3$ | -27
8. $(-4)^2$ | 16 | $(-4)^3$ | -64 | $(-4)^2$ | -16
9. $(-5)^2$ | 25 | $(-5)^3$ | -125 | $(-5)^3$ | -125

10. The number is 8.
11. The number is 5.
1. 5 centimeters
2. 23.3 feet
3. 10 miles, 4 miles shorter
4. 15 miles

1. about 25,133 miles
2. 254.5 feet, 75.4
3. 14.1 ft³
4. 45,000
5. 5,506,000,000
Part 2

Training and Teaching Plans
Introduction

Part 2 presents research-based training and teaching plans. Our goal is to present adaptable plans and activities and encourage modification and tailoring that allows you to best meet your training and instructional needs. The 7 chapters include the following topics:

- Defeating Math Anxiety
- Learning with Intelligence and Style
- Real Learning with Realia
- Projects to Enhance Learning
- Teaching Multi-level Learners
- Fun with Beginning Math
- Fun with Algebra, Geometry, and Graphing

As is always the case, knowledge is best understood and interpreted when it meets the needs of the learner. Knowing the needs of the participants, the trainer is in the best position to customize activities. Each chapter includes a variety of activities so that you can customize training for both new and experienced participants.

When using the classroom activities in a workshop setting let participants know the purpose of the training, “To help you help students learn how to ...” Explain, “I will act as instructor to model activities so that you experience the benefits of actually taking part just as if you were a student in the Adult Basic Skills classroom.”
Defeating Math Anxiety

Dianne B. Barber
2004 ABSPD Institute Participants

Math anxiety is an emotional reaction ... which harms future learning. A good experience ... can overcome these feelings and ... future achievement in math can be attained.

Ellen Freedman
Overview

In the 1970s the term “math anxiety” was coined to describe the “panic, helplessness and mental disorganization that arises among some people when they are required to solve a mathematical problem” (Tobias, 1978).

Many students enter the Adult Basic Skills classroom with math anxiety, therefore instructors need teaching strategies that help students increase a personal sense of self and open doors to interesting classes, college majors, and careers that they previously shunned due to their fear of math.

This training plan focuses on the nature, causes, and effects of math anxiety and provides a variety of ideas and tools.

Goal

The goal of this plan is to provide professional development using research-based methods, strategies, and techniques for empowering instructors to help students overcome math anxiety.

Objectives

Participants will

- define math anxiety;
- identify characteristics and underlying causes of math anxiety;
- develop strategies to dispel math myths; and
- apply strategies and techniques to help students reduce math anxiety.
Summary of Activities

<table>
<thead>
<tr>
<th>Activity</th>
<th>Materials</th>
<th>Time</th>
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<tbody>
<tr>
<td>Activity 9.1: Math Anxiety and Math Myths</td>
<td>“Math Anxiety is…” and “Math Myths” handouts, flip charts, markers, and scrap paper or sticky notes</td>
<td>60 minutes</td>
</tr>
<tr>
<td>Activity 9.2: My Experiences with Math</td>
<td>“My Experiences with Math” and “Do you Have Math Anxiety? A Self Test” handouts, flip charts, and markers</td>
<td>20 minutes</td>
</tr>
<tr>
<td>Activity 9.3: Characteristics of Math Anxiety</td>
<td>“Characteristics of Math Anxiety” handout, definition of math anxiety for display, sticky notes, flip charts, and markers</td>
<td>40 - 60 minutes</td>
</tr>
<tr>
<td>Activity 9.4: Techniques to Reduce Anxiety</td>
<td>“Breathing to Relax,” “Games We Play, Games Others Play,” “Positive Self-talk Statements,” “Math Anxiety Bill of Rights,” “Math Anxiety Code of Responsibilities,” and “Math Teachers’ Ten Commandments” handouts</td>
<td>60 - 90 minutes</td>
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Authors

This topic includes excerpts of professional development plans submitted by the following 2004 ABSPD Institute participants.

Beth Agnello, Pamlico Community College
Olivia Andrews-Beard, Durham Technical Community College
Heidi Austin, Appalachian State University
Carole Brown, Catawba Valley Community College
Brenda Childers, Appalachian State University
Brenda Cousins, Halifax Community College
Sonja Godwin, Southeastern Community College
Leta Hartley, Appalachian State University
Nathan Karner, Appalachian State University
Helen Keller, Western Piedmont Community College
Jean Lilly, Western Piedmont Community College
Sarah Loudermelk, Catawba Valley Community College
Lisa Mauney, Western Piedmont Community College
Evelyn McCray, Fayetteville Technical Community College
Barbara Percell, Brunswick Community College
Mary Tucker, Catawba Valley Community College
Activity 9.1: Math Anxiety and Math Myths

What is math anxiety? What causes it? Why do some people experience math anxiety and others do not? Many commonly held views are based on myths, thus giving false impressions about math. Having a clear definition of math anxiety enables learners to discuss their fears. This activity is designed to help learners understand math anxiety and its causes.

Preparation

1. Make copies of the “Math Myths” handout and cut the myths apart. Prepare enough individual myths so that each participant will have one. You may want to make copies of the “Math Anxiety is…” and “Math Myths” handouts so each participant has a copy at the end of the activity.

2. Set up a flip chart with markers for use during discussion.

3. Have available flip charts, markers and scrap paper or sticky notes for each small group.

Conducting the Activity

1. Ask participants to complete the sentence, “Math anxiety is…”

2. Divide participants into small groups.

3. Each group combines their responses into one definition of math anxiety.

4. Each group writes their definition on a flip chart, shares it with the other groups, and posts it on the wall.

5. As a large group, discuss and compare the definitions generated by the small groups with the definitions found in research.
6. Ask participants to brainstorm beliefs about math. For example, only smart people can be mathematicians, not everyone can do math, etc. List beliefs on flip chart.

7. Give each participant one of the twelve math myths.

8. Participants form groups according to their math myth.

9. Each small group prepares a presentation of their myth. They may use a skit, make a poster, do a mini lecture, write and read a story, etc.

10. Each group presents its myth.

11. Discuss the role math myths and anxiety play in the classroom.

12. Discuss changes participants plan to make in their teaching as a result of what was learned during this activity.
Math Anxiety is ...

...an intense emotional feeling that people have about their inability to understand and do mathematics.

...an irrational dread of mathematics that interferes with manipulating numbers and solving mathematical problems within a variety of everyday life and academic situations.

...a feeling of tension and apprehension that interferes with the manipulation of numbers and the solving of mathematical problems in a variety of academic and ordinary life situations.

...a clear-cut, negative, mental, emotional, and/or physical reaction to mathematical thought processes and problem solving.
Math Myths

MEN ARE BETTER IN MATH THAN WOMEN.

Research has failed to show any difference between men and women in mathematical ability. Men are reluctant to admit they have problems so they express difficulty with math by saying, "I could do it if I tried." Women are often too ready to admit inadequacy and say, "I just can't do math."

MATH REQUIRES LOGIC, NOT INTUITION.

Few people are aware that intuition is the cornerstone of doing math and solving problems. Mathematicians always think intuitively first. Everyone has mathematical intuition; but some have not learned to use or trust it. It is amazing how often your first idea turns out to be correct.

MATH IS NOT CREATIVE.

Creativity is as central to mathematics as it is to art, literature, and music. The act of creation involves diametrical opposites—working intensely and relaxing, the frustration of failure and elation of discovery, the satisfaction of seeing all the pieces fit together. It requires imagination, intellect, intuition, and an aesthetic feeling about the rightness of things.

YOU MUST ALWAYS KNOW HOW YOU GOT THE ANSWER.

Getting the answer to a problem and knowing how the answer was derived are independent processes. If you are consistently right, then you know how to do the problem. There is no need to explain it.
THERE IS A BEST WAY TO DO MATH PROBLEMS.
A math problem may be solved by a variety of methods that express individuality and originality—but there is no best way. New and interesting techniques for doing all levels of mathematics, from arithmetic to calculus, have been discovered by students. The way math is done is very individual and personal; the best method is the one that makes you feel most comfortable.

IT IS ALWAYS IMPORTANT TO GET THE ANSWER EXACTLY RIGHT.
The ability to obtain an approximate answer is often more important than getting exact answers. Feelings about the importance of the exact answer often are a reversion to early school years when arithmetic was taught as a feeling that you were "good" when you got the right answer and "bad" when you did not.

IT IS BAD TO COUNT ON YOUR FINGERS.
There is nothing wrong with counting on fingers as an aid to doing arithmetic. Counting on fingers actually indicates an understanding of arithmetic—more understanding than if everything were memorized.

MATHEMATICIANS DO PROBLEMS QUICKLY IN THEIR HEADS.
Solving new problems or learning new material is always difficult and time consuming. The only problems mathematicians do quickly are those they have solved before. Speed is not a measure of ability. It is the result of experience and practice.
MATH REQUIRES A GOOD MEMORY.
Knowing math means that concepts make sense and rules and formulas seem natural. This kind of knowledge cannot be gained through rote memorization.

MATH IS DONE BY WORKING INTENSELY UNTIL THE PROBLEM IS SOLVED.
Solving problems requires both resting and working intensely. Getting away from a problem and later returning to it allows the mind time to assimilate ideas and develop new ones. Often, upon returning to a problem, a new insight is experienced which unlocks the solution.

SOME PEOPLE HAVE A "MATH MIND" AND SOME DON'T.
Belief in myths about how math is done leads to a lack of self-confidence. Self-confidence is one of the most important determining factors in mathematical performance. We have yet to encounter anyone who could not attain his or her goals once the emotional blocks were removed.

THERE IS A MAGIC KEY TO DOING MATH.
There is no formula, rule, or general guideline that suddenly unlocks the mysteries of math. If there is a key to doing math, it is in overcoming anxiety and using the same skills you use to do everything else.

Activity 9.2: My Experiences with Math

It is important for learners to understand that they share similar math experiences. This activity allows participants to reflect upon and discuss both positive and negative experiences.

Preparation

1. Make copies of the “My Experiences with Math” handout, one for each participant.
2. Have available flip charts and markers for each small group.

Conducting the Activity

1. Provide each participant with the “My Experiences with Math” handout.
2. Briefly explain to participants that you want them to write about their math history, including positive and negative experiences, memories of how others influenced them, and how they dealt with recent situations involving math. Participants complete the handout based on their personal experiences.
3. Divide participants into groups of four to six.
4. Each group chooses a recorder to record key points from the discussion.
5. Participants share and discuss what they wrote with others in their group paying particular attention to similarities and differences in their experiences.
6. Groups identify key experiences, both positive and negative to share with the large group. Ask the recorder to record these on a flip chart.
7. Each group shares key experiences.
8. Ask participants, “Based on the discussions and information shared, what do you think are the causes of math anxiety?” Record answers on flip chart.

9. Provide each participant a copy of the “Do You Have Math Anxiety? A Self Test” handout. Ask participants to complete the test as if they were one of their students. Allow participants to share their findings.

10. Close with a brief review by participants of what math anxiety is and what causes it.
My Experiences with Math

1. Briefly describe your chronological history in terms of the negative and positive experiences you have had with math. Include your earliest memories, as well as memories of how your teachers and your family influenced you in math.

2. Describe how you have dealt with recent situations involving math in other classes, on the job, or in daily life situations.

3. Explain how math could help to accomplish your educational goals, earn more money, choose a career, or to succeed in any other aspect of your life.

Do You Have Math Anxiety?
A Self Test

Rate your answers from 1(disagree) to 5 (agree).

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<tr>
<th></th>
<th>Disagree</th>
<th>Agree</th>
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<tr>
<td>1. I cringe when I have to go to math class.</td>
<td>1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>2. I am uneasy about going to the board in math class.</td>
<td>1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>3. I am afraid to ask questions in math class.</td>
<td>1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>4. I am always worried about being called on in math class.</td>
<td>1 2 3 4 5</td>
<td></td>
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<tr>
<td>5. I understand math now, but I worry that it is going to get really difficult soon.</td>
<td>1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>6. I tend to zone out in math class.</td>
<td>1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>7. I fear math tests more than any other test.</td>
<td>1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>8. I do not know how to study for math tests.</td>
<td>1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>9. It is clear to me in math class, but when I go home it is like I was never there.</td>
<td>1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>10. I am afraid I will not be able to keep up with the rest of the class.</td>
<td>1 2 3 4 5</td>
<td></td>
</tr>
</tbody>
</table>

Add answers to find your total score. Total Score ________

Check score below:

40 – 50 Sure thing, you have math anxiety.
30 – 39 No doubt! You are still fearful about math.
20 – 29 On the fence!
10 – 19 Wow! Very little anxiety here.

Activity 9.3: Characteristics of Math Anxiety

Adult learners may believe they are the only ones who ever developed a particular physical symptom or had an emotional reaction to math. Feeling their reactions were unusually extreme can reinforce a perception that math is more difficult for them than for others. Learning that their reactions to math are not unique can be a major step toward addressing math anxiety.

Preparation

1. Write the following definition of math anxiety on a flip chart, transparency, or white board.

   Not unlike a disease, math anxiety is a clear-cut, negative, mental, emotional, and/or physical reaction to mathematical thought processes and problem solving.

2. Make copies of the “Characteristics of Math Anxiety” handout for each participant.

3. Have flip charts, markers, and sticky notes available.

Conducting the Activity

1. Display and read aloud the definition of math anxiety.

2. Participants individually record characteristics of math anxiety on sticky notes, one characteristic per note.

3. Divide participants into groups of three. Ask triads to sort notes into three groups: mental, emotional, and physical.

4. Ask each member of the triad to select one group of notes, i.e., mental, emotional, physical.

5. Jigsaw into three new groups, i.e. mental, emotional, and physical.

6. Give each group a flip chart on which to arrange their sticky notes. Ask that the appropriate title be placed on their flip chart.
7. Groups “weed-out” duplications and make a list of the characteristics under their heading.

8. Each group chooses a spokesperson to share the results with the large group.

9. Distribute the “Characteristics of Math Anxiety” handout.

10. Participants compare characteristics listed on the handout with characteristics listed by the group. Add any missing characteristics to the handout.
Characteristics of Math Anxiety

<table>
<thead>
<tr>
<th>Mental</th>
<th>Physical</th>
<th>Emotional</th>
</tr>
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<tbody>
<tr>
<td>Confused</td>
<td>Tired</td>
<td>Depressed</td>
</tr>
<tr>
<td>Uncertain</td>
<td>Headache</td>
<td>Angry</td>
</tr>
<tr>
<td>Lost</td>
<td>Sweaty/Hot</td>
<td>Frustrated</td>
</tr>
<tr>
<td>Defeated</td>
<td>Tears/Crying</td>
<td>Anxious</td>
</tr>
<tr>
<td>Blocked</td>
<td>Stomachache</td>
<td>Sad</td>
</tr>
<tr>
<td>Isolated</td>
<td>Faster Heart Beat</td>
<td>Impatient</td>
</tr>
</tbody>
</table>

Characteristics of Students with Math Anxiety

<table>
<thead>
<tr>
<th>Helplessness</th>
<th>Easily distracted</th>
<th>Withdrawal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asking others for answers</td>
<td>Concepts do not sink in and are not retained</td>
<td>Nervous movement, i.e., pencil or foot tapping</td>
</tr>
<tr>
<td>Short attention span, daydreaming</td>
<td>Negative comments</td>
<td>Avoiding eye contact with instructor</td>
</tr>
<tr>
<td>Avoidance</td>
<td>Puzzled looks</td>
<td>Hostility</td>
</tr>
</tbody>
</table>

Classroom Factors

<table>
<thead>
<tr>
<th>Stressful</th>
<th>Supportive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rigid, one approach is acceptable</td>
<td>Creative, different approaches welcomed</td>
</tr>
<tr>
<td>Questions treated with scorn</td>
<td>Instructor invites questions with body language, tone, and words—no stupid questions!</td>
</tr>
<tr>
<td>Mistakes emphasized</td>
<td>Small successes are celebrated and built on</td>
</tr>
<tr>
<td>Student labeled, instructor allows disrespectful comments, ridicule</td>
<td>Diversity is embraced (learning styles, pace, and ease of mastering concepts)</td>
</tr>
</tbody>
</table>
Activity 9.4: Techniques to Reduce Math Anxiety

Math anxiety is learned. With the realization that math anxiety is a problem that many share comes the feeling that there is hope. Learning ways to reduce anxiety through relaxation techniques and positive self-talk help learners begin the journey to succeed in math. We constantly talk to ourselves; however, often, we are criticizing and condemning ourselves. Negative self-talk is self-defeating. Consciously choose to replace negative with positive self-talk. Breathing to relax and changing negative self-talk into positive self-talk are just two of the many activities learners may use to reduce math anxiety.

Preparation

1. Make copies for each participant of the following handouts:
   a. Breathing to Relax: 4-7-8
   b. Games We Play, Games Others Play
   c. Positive Self-talk Statements
   d. Math Anxiety Bill of Rights
   e. Math Anxiety Code of Responsibilities
   f. Math Teachers’ Ten Commandments

2. Prior to conducting the workshop you may want to prepare a positive statement for each of the negative statements in the “Games We Play, Games Others Play” handout.

Conducting the Activity

1. Breathing to Relax: 4-7-8. See attached instructions. Demonstrate “Breathing to Relax” and do it several times with participants.
2. Discuss positive and negative self-talk. Be sure to include the following statement in the discussion:
   a. If you believe in something, whether it is good or bad, it becomes true for you and, in effect, it becomes reality.
   b. Once we believe we can do something, we start behaving in ways to make it happen.
   c. Believe you will succeed in math and you will!
3. Distribute the “Games We Play, Games Others Play” handout.
4. Participants work in pairs to write positive statements to replace the negative statements listed on the handout. Model an example such as, replacing the negative statement, “I have the right answer but I did it the wrong way.” with a positive statement such as, “I have the right answer. I did it a different way but there are a lot of ways to do math.” If participants have difficulty writing positive statements give them the “Positive Self-talk Statements” handout.
5. Distribute the “Positive Self-talk Statements” handout. Participants check all statements that are similar to those they wrote, add new statement to the handout and share with others.
6. Discuss other ways that instructors might EMPOWER students. Record suggestions on the board or flip chart. Be sure the following are included in the discussion.
   a. Ask questions.
   b. Consider math a foreign language – it must be practiced.
   c. Do not rely on memorization; rely on understanding.
   d. Study math according to your learning style.
   e. Get help when you do not understand something.
f. Be relaxed and comfortable when practicing math.

g. Talk mathematics with peers.

h. Take responsibility for your own successes and failures.

7. Give participants the “Math Anxiety Bill of Rights,” “Math Anxiety Code of Responsibilities,” and “Math Teachers’ Ten Commandments” handouts. Ask participants to read and discuss how these might be used to EMPOWER their students.
Breathing to Relax: 4—7—8

By Dr. Andrew Weil

Since breathing is something we can control and regulate, it is a useful tool for achieving a relaxed and clear state of mind. Try the following exercise to relax, reduce stress and reduce anxiety. It is simple, takes almost no time and can be done anywhere. Although you can do the exercise in any position, sit with your back straight while learning the exercise.

The Exercise

You will inhale through your nose and exhale through your mouth. During the exhale try keeping your lips pursed (almost like you are slowly blowing out a candle).

1. Exhale completely though your mouth making a whoosh sound.
2. Close your mouth and inhale quietly through your nose, mentally counting to four (4).
3. Hold your breath for a count of seven (7).
4. Exhale completely through your mouth, lips pursed, making a whoosh sound to a count of eight (8).
5. Steps 1-4 are one breath. Now inhale quietly again and repeat the cycle three more times for a total of four breaths.

Notes:

• Exhalation should take twice as long as inhalation.
• If you have trouble holding your breath, speed up the exercise, but keep the ratio of 4:7:8.
• Do the exercise as often as you need it, but do not do more than four breaths at one time.

This exercise is a natural tranquilizer for the nervous system. It gains in power with repetition and practice. Use it whenever anything upsetting happens or whenever you are aware of internal tension. Everyone can benefit from it.
Games We Play, Games Others Play

<table>
<thead>
<tr>
<th>Games We Play</th>
<th>Games Others Play</th>
</tr>
</thead>
<tbody>
<tr>
<td>Everybody knows what to do, except me.</td>
<td>I got the right answer, but I don’t know what I’m doing.</td>
</tr>
<tr>
<td>I don’t do math fast enough.</td>
<td>I don’t have a math mind.</td>
</tr>
<tr>
<td>I’m sure I learned it, but I can’t remember what to do.</td>
<td>I was never good in math so I can’t be good now.</td>
</tr>
<tr>
<td>I knew I couldn’t do math.</td>
<td>Math is unrelated to my life. Why do I need math anyway?</td>
</tr>
<tr>
<td>I got the right answer but I did it the wrong way.</td>
<td>This may be a stupid question, but …</td>
</tr>
</tbody>
</table>
### Games Others Play

<table>
<thead>
<tr>
<th>Games Others Play</th>
<th>You'll just have to work harder in math, and you'll get it.</th>
</tr>
</thead>
<tbody>
<tr>
<td>You will never be able to do math.</td>
<td>You should know that.</td>
</tr>
<tr>
<td>All you have to do to learn math is to work hard.</td>
<td>You did it the wrong way.</td>
</tr>
<tr>
<td>That’s an easy problem.</td>
<td>Why learn math anyway, you’ll never need it?</td>
</tr>
<tr>
<td>The answer is right in front of you, don’t you get it?</td>
<td></td>
</tr>
</tbody>
</table>

Positive Self-talk Statements

1. I’m getting better at math every day.
2. I’m starting to like doing math.
3. I remember more math each day.
4. There are a lot of ways to do math.
5. Everybody uses math and I’m learning it, too.
6. I can understand math when I give myself a chance.
7. Each day, math is a little easier for me.
8. I’m relaxed and confident in working math.
9. Working out math problems is like a puzzle—it’s fun.
10. I’m feeling better about math.
11. Knowing math helps me in everyday problems.
12. I’m becoming a good math student.
13. ________________________________________________
14. ________________________________________________
15. ________________________________________________
16. ________________________________________________

Math Anxiety Bill of Rights

by Sandra Davis

I have the right to learn at my own pace and not feel put down or stupid if I'm slower than someone else.

I have the right to ask whatever questions I have.

I have the right to need extra help.

I have the right to ask a teacher or tutor for help.

I have the right to say I don't understand.

I have the right to not understand.

I have the right to feel good about myself regardless of my abilities in math.

I have the right not to base my self-worth on my math skills.

I have the right to view myself as capable of learning math.

I have the right to evaluate my math instructors and how they teach.

I have the right to relax.

I have the right to be treated as a competent person.

I have the right to dislike math.

I have the right to define success in my own terms.

Math Anxiety Code of Responsibilities

1. I have the responsibility to attend all classes and do all homework as assigned.
2. I have the responsibility to recognize the rights of others to learn at their own pace.
3. I have the responsibility to seek extra help when necessary.
4. I have the responsibility to see the teacher … for assistance.
5. I have the responsibility to come to class prepared, homework finished and/or questions to ask.
6. I have the responsibility to speak up when I don't understand.
7. I have the responsibility to give math at least the same effort I give to other subjects.
8. I have the responsibility to begin my math study at my current skill level.
9. I am responsible for my attitudes about my abilities.
10. I have the responsibility for learning and practicing relaxation skills.
11. I have the responsibility to act as a competent adult.
12. I have the responsibility to approach math with an open mind rather than fighting it.
13. I have the responsibility to be realistic about my goals and expectations.

Math Teachers’ Ten Commandments

by Donald Edge and Ellen Freedman

1. Thou shalt accept the challenge of teaching math and educate thyself in every way so that students will learn.

2. Thou shalt recognize that some students fear or dislike math and be compassionate and understanding when teaching.

3. Thou shalt convey to students that their self worth is unrelated to their math skills.

4. Thou shalt adapt teaching strategies to meet the different learning styles of students.

5. Thou shalt respect all student questions as you would have them respect yours.

6. Thou shalt pursue the response of “I still don’t understand” through different avenues until there is understanding.

7. Thou shalt not ask a class, “Do you understand?” Instead, though shalt determine what each student knows and does not know, and address student problems individually.

8. Thou shalt identify students in need of extra help and make certain they get it.

9. Thou shalt actively involve students in class.

10. Though they may at times seem few, thou shalt count thy blessings.

Learning with Intelligence and Style

Dianne B. Barber
2004 ABSPD Institute Participants

Intelligence is the ability to respond successfully to new situations and the capacity to learn from one’s past experiences.

Dr. Howard Gardner
Overview

People learn in a variety of ways. They can experience the same class in different ways. Some people do well in a lecture setting and some do not. Some people need hands-on learning to comprehend information. Some people learn well in groups and some people prefer working individually.

Most of our adult students have not done well in the classroom setting. They may not have been taught in a way that triggers their preferred learning style. Instructors of mathematics can help frustrated and math anxious students by learning about teaching and learning styles.

Goal

The goal of this plan is to provide professional development using research based methods, strategies, and techniques for empowering instructors to enhance the learning environment through an understanding and application of multiple intelligences and teaching and learning styles.

Objectives

Participants will

• use Gardner’s eight multiple intelligences;
• recognize that students have a combination of intelligences and learning preferences;
• identify their dominant intelligences and learning style; and
• use the intelligences and learning preferences to enhance math teaching.
Summary of Activities

<table>
<thead>
<tr>
<th>Activity</th>
<th>Materials</th>
<th>Time</th>
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</thead>
<tbody>
<tr>
<td><strong>Activity 10.1:</strong> Telling is NOT Teaching</td>
<td>1 sheet of paper for each participant</td>
<td>10 - 15 minutes</td>
</tr>
<tr>
<td><strong>Activity 10.2:</strong> Multiple Intelligences</td>
<td>“Test Yourself” and “Engaging the Intelligences” handouts, flip charts, and markers</td>
<td>60 – 90 minutes</td>
</tr>
<tr>
<td><strong>Activity 10.3:</strong> Learning Styles</td>
<td>“Learning Styles Checklist,” Learning Preferences,” and “Teaching Strategies for Math” handouts, flip charts, and markers.</td>
<td>60 – 90 minutes</td>
</tr>
</tbody>
</table>

Authors

This topic includes excerpts of professional development plans submitted by the following 2004 ABSPD Institute participants.

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Activity 10.1: Telling is NOT Teaching

This activity emphasizes the teaching-learning process.

Preparation

Have a sheet of paper available for each participant.

Conducting the Activity

1. Give each participant a sheet of paper.
2. Participants hold the sheet of paper in front of them.
3. Participants close their eyes and follow the spoken directions. Remind participants—no peeking.
4. Directions.
   a. Fold your paper in half
   b. Tear off the upper right hand corner
   c. Fold it in half again and tear off the upper left-hand corner of the sheet.
   d. Fold it in half again.
   e. Now tear off the lower right hand corner of the sheet.
   f. Open your eyes and see what you have.
5. Announce, “If I did a good job of communicating and you did a good job of listening, all of our sheets should look the same.”
6. Observe differences.
7. Why did your papers not exactly match mine? Discuss.
8. Point out what a poor job you did as an instructor. Use statements such as, “I did not allow for questions.” “I failed to recognize an important fact.” “Telling is not teaching.”
9. Close the activity by stating, “This means that what an instructor says or does is not the measure of success; what the students say or do is.”
Activity 10.2: Multiple Intelligences

Gardner (1999) developed the idea that people have eight different potential pathways to learning. He identified those intelligences as linguistic-verbal, logical-mathematical, visual-spatial, musical, bodily-kinesthetic, intrapersonal, interpersonal, and naturalist. A person can have any combination of these intelligences. We learn best by the intelligence(s) that is(are) dominant. This activity helps individuals identify their stronger and weaker intelligences and understand how to use different intelligences to enhance teaching and learning.

Procedure

1. Make copies of “Test Yourself” and “Engaging the Intelligences” handouts.
2. Complete the “Test Yourself” inventory. Plan to share your dominant intelligences with participants.
3. Place a list of intelligences on the board before beginning the activity.
4. Have flip charts and markers available.

Conducting the Activity

1. Discuss with participants that people have different intelligences through which we learn.
2. Let participants choose the one intelligence from the list they think is their strongest. Let participants who chose the same intelligence work together to prepare a list of statements that describe people who have that dominant intelligence. Have them list their statements on flip chart paper and share their list with the larger group.
3. Give each participant a copy of the “Test Yourself” handout. Let participants complete the inventory to see which are their
dominant intelligences. After finishing the inventory, discuss results with participants. Are their dominant intelligences what they thought prior to taking the inventory?

4. Explain to participants that no one uses just one type of intelligence; everyone uses several different intelligences throughout their daily lives. It is just that some intelligences are stronger than others for each individual. Explain that one of the intelligences is not better or more important than another; each has its own strength.

5. Give each participant a copy of the “Engaging the Intelligences” handout. Use ideas from the handout to explain each of the intelligences. Let participants ask questions and discuss the concept. Then involve participants in activities so that they have the opportunity to use each of the intelligences.

6. Provide an opportunity for participants to talk about each activity upon completion. Ask participants how they felt after completing the activity? Did some find the activity easy while others found it hard? Discuss how dominant intelligences influence how one reacts to different activities?

7. Discuss how understanding multiple intelligences might help adult students in their learning and work environments.

8. Discuss how ideas from the “Engaging the Intelligences” handout could be used to incorporate intelligences into math lessons. Assign each small group one intelligence to brainstorm how to incorporate it into math instruction. Participants could make a list to share with the larger group.

9. Ask participants to brainstorm math applications that are used in each career listed on the “Engaging the Intelligences” handout. Let participants know that an activity such as this allows their students to see the need for learning math.
Test Yourself

It’s not how smart you are that matters, what really counts is how you are smart. That’s the message from noted education professor Howard Gardner of Harvard University.

The practical implementation of Gardner’s "Theory of Multiple Intelligences" forms a significant part of our accelerated learning philosophy. Which of the intelligences do you favor? What are your strengths?

By answering the following questions you will be able to gauge which forms of intelligence are your strongest—and weakest. This will enable you to focus on making sure you make the most of your existing abilities and—if you so desire—see if you can develop some of the others.

Let us emphasize that most of us have a mixed portfolio of intelligences and that there is no purpose in trying to simply label someone as a ‘logical-mathematical’ type or a ‘bodily-kinesthetic’ type. The checklist is designed to help you develop a fuller appreciation of the intelligences you enjoy.

Check each statement which applies to you and add the totals.

Compare the totals from all eight intelligences and you will readily see your greatest strengths and weaknesses. The higher your score, the more you favor that particular intelligence.

Test Yourself
Linguistic–Verbal/Language

- You enjoy word play—making puns, tongue-twisters, limericks.
- You read everything—books, magazines, newspapers, even product labels.
- You can easily express yourself either orally or in writing, i.e., you’re a good story-teller or writer.
- You pepper your conversation with frequent allusions to things you’ve read or heard.
- You like to do crosswords, play Scrabble, or have a go at other word puzzles.
- People sometimes have to ask you to explain a word you’ve used.
- In school you preferred subjects such as English, history and social studies.
- You can hold your own in verbal arguments or debates.
- You like to talk through problems, explain solutions, ask questions.
- You can readily absorb information from the radio or audio cassettes.

_____ Total
Test Yourself
Logical–Mathematical

☐ You enjoy working with numbers and can do mental calculations.

☐ You’re interested in new scientific advances.

☐ You can easily balance your checkbook; do the household budget.

☐ You like to put together a detailed itinerary for vacations or business trips.

☐ You enjoy the challenge of brain teasers or other puzzles that require logical thinking.

☐ You tend to find the logical flaws in things people say and do.

☐ Math and science were among your favorite subjects in school.

☐ You can find specific examples to support a general point of view.


☐ You need to categorize, group or quantify things to properly appreciate their relevance.

___ Total
Test Yourself
Visual–Spatial

☐ You have an appreciation of the arts.

☐ You tend to make a visual record of events with a camera or camcorder.

☐ You find yourself doodling when taking notes or thinking through something.

☐ You have no problem reading maps and navigating.

☐ You enjoy visual games such as jigsaw puzzles and mazes.

☐ You’re quite adept at taking things apart and putting them back together.

☐ In school you liked lessons in art and preferred geometry to algebra.

☐ You often make your point by providing a diagram or drawing.

☐ You can visualize how things look from a different perspective.

☐ You prefer reading material that is heavily illustrated.

___ Total
Test Yourself
Musical

☐ You can play a musical instrument.
☐ You can manage to sing on key.
☐ Usually, you can remember a tune after hearing it just a couple of times.
☐ You often listen to music at home and in your car.
☐ You find yourself tapping in time to music.
☐ You can identify different musical instruments.
☐ Theme music or commercial jingles often pop into your head.
☐ You can’t imagine life without music.
☐ You often whistle or hum a tune.
☐ You like a musical background when you’re working.

___ Total
Test Yourself
Bodily–Kinesthetic/Movement

- You take part in a sport or regularly perform some kind of physical exercise.
- You are quite adept at “do-it-yourself.”
- You like to think through problems while engaged in a physical pursuit such as walking or running.
- You do not mind getting up on the dance floor.
- You like the most thrilling rides at the fun fair.
- You need to physically handle something to fully understand it.
- The most enjoyable classes in school were PE and any handicrafts lessons.
- You use hand gestures or other kinds of body language to express yourself.
- You like rough and tumble play with children.
- You need to tackle a new learning experience “hands on” rather than reading a manual or watching a video.

___ Total
Test Yourself
Intrapersonal/Self

☐ You keep a personal diary or log to record your innermost thoughts.

☐ You often spend “quiet time” reflecting on the important issues in your life.

☐ You set your own goals—you know where you’re going.

☐ You are an independent thinker—you know your own mind, make up your own mind.

☐ You have a private hobby or interest which you don’t really share with anyone else.

☐ You like to go fishing by yourself or take a solitary hike. You’re happy with your own company.

☐ Your idea of a good vacation is an isolated hilltop cabin rather than a five-star resort and lots of people.

☐ You have a realistic idea of your own strengths and weaknesses.

☐ You have attended self-improvement workshops or been through some kind of counseling to learn more about yourself.

☐ You work for yourself—or have seriously contemplated “doing your own thing.”

___ Total
Test Yourself
Interpersonal/Social

☐ You enjoy working with other people as part of a group or committee.

☐ You take great pride in being a mentor to someone else.

☐ People tend to come to you for advice.

☐ You prefer team sports—such as basketball, softball, soccer, football—to individual sports such as swimming and running.

☐ You like games involving other people—bridge, Monopoly, Trivial Pursuit.

☐ You’re a social butterfly. You would much prefer to be at a party rather than home alone watching television.

☐ You have several very close personal friends.

☐ You communicate well with people and can help resolve disputes.

☐ You have no hesitation in taking the lead; showing other people how to get things done.

☐ You talk over problems with others rather than trying to resolve them by yourself.

____ Total
Test Yourself
Naturalist/Nature

☐ You keep or like pets.

☐ You can recognize and name many different types of trees, flowers and plants.

☐ You have an interest in and good knowledge of how the body works—where the main internal organs are, for example, and you keep abreast on health issues.

☐ You are conscious of tracks, nests and wildlife while on a walk and can “read” weather signs.

☐ You could envision yourself as a farmer or maybe you like to fish.

☐ You are a keen gardener.

☐ You have an understanding of, and interest in, the main global environmental issues.

☐ You keep reasonably informed about developments in astronomy, the origins of the universe and the evolution of life.

☐ You are interested in social issues, psychology and human motivations.

☐ You consider that conservation of resources and achieving sustainable growth are two of the biggest issues of our times.

___ Total
Engaging the Intelligences

Linguistic–Verbal/Language

Linguistic-verbal intelligence is the ability to use words and language. People who are strong in the language intelligence enjoy saying, hearing, and seeing words. They like telling stories and are motivated by books, records, dramas, and opportunities for writing. These learners have highly developed auditory skills and are generally elegant speakers. They think in words rather than pictures.

Their skills include listening, speaking, writing, story telling, explaining, teaching, using humor, understanding the syntax and meaning of words, remembering information, convincing someone of their point of view, and analyzing language usage. Possible career interests include poets, journalists, writers, teachers, lawyers, politicians, or translators.

Some ways to integrate this intelligence into your teaching are by allowing learners to:

• Look at different kinds of dictionaries.
• Read plays and poetry aloud.
• Write a story for a book or newsletter.
• Keep a journal.
• Read from books written by or for new readers.
• Use a tape recorder to tape stories and write them down later.
• Read together, i.e., choral reading.
• Read aloud to each other.
• Read a section, then explain what you’ve read.
• Explore and develop the love of words, i.e., meaning of words, origin of words, idioms, and names. Research your name.
Logical/Mathematical

Logical intelligence is the ability to use reason, logic, and numbers. People who are strong in the **logical/mathematical** intelligence enjoy exploring how things are related. They like to understand how things work. They like mathematical concepts, enjoy puzzles and manipulative games, and are good at critical thinking. These learners think conceptually in logical and numerical patterns making connections between pieces of information. Always curious about the world around them, these learners ask lots of questions and like to do experiments.

Their skills include problem solving, classifying and categorizing information, working with abstract concepts to figure out the relationship of each to the other, doing controlled experiments, questioning and wondering about natural events, performing complex mathematical calculations, and working with geometric shapes. Possible career paths include scientists, engineers, computer programmers, researchers, accountants, and mathematicians.

Some ways to integrate this intelligence into your teaching are by allowing learners to:

- Arrange cartoons and other pictures in a logical sequence.
- Sort, categorize, and characterize word lists.
- Play games that require critical thinking. For example, pick the one word that doesn’t fit: chair, table, paper clip, sofa. Explain why it doesn’t fit.
- Work with scrambled sentences. Talk about what happens when the order is changed.
- Write the directions for completing a simple job like starting a car or tying a shoe.
- Look at advertisements critically. What are they using to persuade you to buy their product?
Visual-Spatial

Visual-spatial intelligence is the ability to perceive the visual. People who are strong in the visual-spatial intelligence remember things visually, including exact sizes and shapes of objects. They like posters, charts, and graphics. They like any kind of visual clues. They enjoy drawing. These learners tend to think in pictures and need to create vivid mental images to retain information. They enjoy looking at maps, charts, pictures, videos, and movies.

Their skills include puzzle building, reading, writing, understanding charts and graphs, a good sense of direction, sketching, painting, creating visual metaphors and analogies (perhaps through the visual arts), manipulating images, constructing, fixing, designing practical objects, and interpreting visual images. Possible career interests include navigators, sculptors, visual artists, inventors, architects, interior designers, mechanics, and engineers.

Some ways to integrate this intelligence into your teaching are by allowing learners to:

- Write a language experience story and illustrate it.
- Study and create maps, diagrams and graphs.
- Color code words so each syllable is a different color.
- Take a survey. Put the information in a chart.
- Write words vertically.
- Cut out words from a magazine and use them in a letter.
- Use pictures to stimulate reading or writing.
- Visualize spelling words.
- Use the say-copy-look method of spelling.
- Use colorful newspapers like USA Today.
- Use crossword puzzles.
Musical intelligence is the ability to produce and appreciate music. People who are strong in the musical intelligence like the rhythm and sound of language. They like poems, songs, and jingles. They enjoy humming or singing along with music. These musically inclined learners think in sounds, rhythms and patterns. They immediately respond to music either appreciating or criticizing what they hear. Many of these learners are extremely sensitive to environmental sounds (e.g. crickets, bells, dripping taps).

Their skills include singing, whistling, playing musical instruments, recognizing tonal patterns, composing music, remembering melodies, and understanding the structure and rhythm of music. Possible career paths include musicians, disc jockeys, singers, and composers.

Some ways to integrate this intelligence into your teaching are by allowing learners to:

- Use a familiar tune, song, or rap beat to teach spelling rules or to remember words in a series for a test.
- Create a poem with an emphasis on certain sounds for pronunciation.
- Clap out or walk out the sounds of syllables.
- Read together (choral reading) to work on fluency and intonation.
- Read a story with great emotion — sad, then happy, then angry. Talk about what changes — is it only tone?
- Read lyrics to music.
- Use music as background while reviewing and for helping to remember new material.
- Use rhymes to remember spelling rules, i.e., "I before E except after C."
Bodily–Kinesthetic/Body Movement

Bodily-kinesthetic intelligence is the ability to control body movements and handle objects skillfully. People who are strong in the body movement intelligence like to move, dance, wiggle, walk, and swim. They are often good at sports, have good fine motor skills, and like to take things apart and put them back together. These learners express themselves through movement. They have a good sense of balance and eye-hand coordination. Through interacting with the space around them, they are able to remember and process information.

Their skills include dancing, physical coordination, sports, hands-on experimentation; using body language, crafts, acting, miming; using their hands to create or build; and expressing emotions through the body. Possible career paths include athletes, physical education teachers, dancers, actors, firefighters, and artisans.

Some ways to integrate this intelligence into your teaching are by allowing learners to:

• Go through your wallet and pull out three things to talk about.
• Handle a Koosh ball or a worry stone during class.
• Use magnetic letters, letter blocks, or letters on index cards to spell words.
• Take a walk while discussing a story, gathering ideas for a story or reading all the words you find during the walk.
• Use your whole arm (extend without bending your elbow) to write letters and words in the air.
• Change the place where you write and use different kinds of tools to write, i.e., typewriter, computer, blackboard, or large pieces of paper.
Intrapersonal/Self

Intrapersonal intelligence is the ability to self-reflect and to be aware of one's inner state of being. These learners try to understand their inner feelings, dreams, relationships with others, and strengths and weaknesses.

Their skills include recognizing their own strengths and weaknesses, reflecting and analyzing themselves, awareness of their inner feelings, desires and dreams, evaluating their thinking patterns, reasoning with themselves, and understanding their role in relationship to others. Possible career paths include researchers, theorists, and philosophers.

Some ways to integrate this intelligence into your teaching are by allowing learners to:

- Go on "guided imagery" tours.
- Set aside time to reflect on new ideas and information.
- Encourage journal writing.
- Work on the computer.
- Practice breathing for relaxation.
- Use brainstorming methods before reading.
- Listen to and read "how to" tapes and books.
- Read "inspirational" thought-for-the-day books.
- Read cookbooks.
Interpersonal/Social

Interpersonal intelligence is the ability to relate to and understand others. People who are strong in the social intelligence like to develop ideas and learn from other people. They like to talk and have good social skills. These learners try to see things from other people’s point of view in order to understand how they think and feel. They often have an uncanny ability to sense feelings, intentions and motivations. They are great organizers, although they sometimes resort to manipulation. Generally they try to maintain peace in group settings and encourage cooperation. They use both verbal (e.g., speaking) and non-verbal language (e.g., eye contact, body language) to open communication channels with others.

Their skills include seeing things from other perspectives (dual-perspective), listening, using empathy, understanding other people’s moods and feelings, counseling, cooperating with groups, noticing people’s moods, motivations and intentions, communicating both verbally and non-verbally, building trust, peaceful conflict resolution, and establishing positive relations with other people. Possible career paths include counselors, salespeople, politicians, or business people.

Some ways to integrate this intelligence into your teaching are by allowing learners to:

• Take part in group discussions or discuss a topic one-to-one.
• Read a dialogue or a play together.
• Do team learning/investigating projects.
• Set up interview questions. Interview your family. Write the results.
• Write notes to one another instead of talking.
Naturalist/Nature

People who are strong in the nature intelligence enjoy interacting with the outside world. They are adept at noticing patterns in nature and can easily distinguish between different species of flora and fauna.

Their skills include gardening, landscaping, identifying flora and fauna, understanding the environment, predicting weather, and caring for animals. Career interests include biologists, farmers, landscapers, and park rangers.

Some ways to integrate this intelligence into your teaching are by allowing learners to:

• Spend time outside noticing patterns in nature.
• Read books and articles about nature and the environment.
• Compare seeds, seedlings, and adult plants. Mix them up and ask your learners to match each seed to its corresponding seedling and adult.

Activity 10.3: Learning Styles

Understanding one’s teaching style, as it relates to students’ learning styles, is a key factor in communication between instructor and student. Knowing students’ learning styles enables the instructor to vary methods of teaching to enhance student success in math. Utilizing such information results in higher levels of success for every student.

This activity includes a “Learning Styles Checklist” or have participants access the Internet to complete an online inventory. Search the Internet for “learning styles inventories.” If you choose an online inventory, adjust this activity to correspond to your choice.

Preparation

2. Complete the Learning Styles Checklist. Be ready to share your learning style with participants.
3. Have flip charts and markers available.

Conducting the Activity

1. Discuss with participants that people have different learning preferences.
2. Distribute the “Learning Styles Checklist” handout. Allow time for participants to complete it.
3. Ask participants to compare their 3 totals, i.e., visual total, auditory total, and tactile/kinesthetic total. The largest total is the preferred learning style.
4. Assign an area of the room for participants to group according to their learning styles, i.e., all visual together, all auditory together, and all tactile/kinesthetic together. If you have a large
group you may want to make smaller groups by having more than one group for each learning style.

5. Ask each group to identify someone to take notes as they share ideas. Ask participants to identify the most effective and least effective methods for them to learn math.

6. After a few minutes ask the note taker from each group to briefly share the groups most effective and least effective method for learning math. Record these on a flip chart.

7. Compare group feedback. The most effective method for some groups will likely be the least effective for others. Point this out.

8. Distribute the “Learning Preferences” handout.

9. Give each group a sheet of flip chart paper and marker(s). Ask participants to brainstorm and record strategies they could incorporate into their math instruction that would enhance the learning for students with their preferred learning style. Advise participants that they may use ideas from the “Learning Preferences” handout to help develop their math instructional strategies.

10. After they have finished brainstorming ask groups to identify several teaching strategies they feel would be most appropriate to accommodate that learning style within their classroom. Give them several sheets of flip chart paper to record the strategies.

11. Each group shares their strategies.

12. Facilitate a whole group discussion about how these strategies could be used within the different learning environments in Adult Basic Skills, i.e., labs, individual instruction, multi-level classroom, etc.

13. Distribute the “Teaching Strategies for Math” handout. Discuss any teaching strategies included on the handout that were not discussed earlier.

14. Close by expressing the importance of teaching in a way that all students get to learn in their preferred learning style some of the time while being required to learn in their non-preferred style other times to help them develop new learning skills.
Learning Styles Checklist
Source Unknown

The following three pages contains statements concerning your like or dislike of certain tasks. Read each statement carefully and consider whether it applies to you.

On the line beside each statement write:

5 – almost always applies
4 – often applies
3 – sometimes applies
2 – applies once in a while
1 – almost never applies

Answer honestly. There are no “right,” “wrong,” “good,” or “bad” answers.

Total your score for each section. Record totals on the lines below:

Visual Total
Auditory Total
Tactile/kinesthetic Total

The area with the largest total is your preferred learning style.
Visual

Read each statement carefully and consider whether it applies to you. On the line beside each statement write:

5 – almost always applies
4 – often applies
3 – sometimes applies
2 – applies once in a while
1 – almost never applies

_____ 1. I enjoy doodling and even my notes have lots of pictures, arrows, etc. in them.

_____ 2. I remember things better if I write them down, even if I do not go back to what I have written.

_____ 3. When trying to remember a new phone number or a spelling word, it helps me to get a picture of it in my head.

_____ 4. When recalling information during a test, I can see in my mind’s eye the textbook page and the information on it.

_____ 5. Unless I write down the directions to a place, I am likely to get lost or arrive late.

_____ 6. During lectures I can listen better if I look at a person speaking.

_____ 7. I can clearly and easily visualize people, places, and documents in my head.

_____ 8. It is hard for me to concentrate on what a person is saying if there is background noise. It is easier for me to get work done in a quiet place.

_____ 9. It is difficult for me to remember jokes I have heard.

_____ 10. I get some great ideas but I forget them unless I write them down right away.

______ VISUAL TOTAL
Auditory

Read each statement carefully and consider whether it applies to you. On the line beside each statement write:

5 – almost always applies
4 – often applies
3 – sometimes applies
2 – applies once in a while
1 – almost never applies

_____ 1. When reading, I hear the words in my head or I read aloud.

_____ 2. When memorizing something, it helps me to recite it over and over.

_____ 3. If I want to understand something, it helps me to discuss it with someone or to try to explain it to someone else.

_____ 4. I like to finish one task before beginning another.

_____ 5. It is hard for me to picture things in my head.

_____ 6. I would rather listen to a tape of a lecture rather than read the same information in a textbook.

_____ 7. I would rather turn in a tape-recorded report than a written report.

_____ 8. I can easily follow what a teacher is saying even though my eyes are closed or I am staring out the window.

_____ 9. I talk to myself when problem solving, writing, or doing homework.

_____ 10. I prefer to have someone tell me how to do something rather than have to read the directions.

_______ Auditory Total
Tactile/Kinesthetic

Read each statement carefully and consider whether it applies to you. On the line beside each statement write:
5 – almost always applies
4 – often applies
3 – sometimes applies
2 – applies once in a while
1 – almost never applies

_____ 1. I do not like to read or listen to directions; I would rather just start doing.
_____ 2. I take notes, but I do not go back and read them.
_____ 3. I can study better with music playing in the background.
_____ 4. I do not start a task with a definite plan in mind; I like to try different things until I hit on something that works.
_____ 5. My space, room, desk, locker, etc. looks disorganized, but I know where everything is.
_____ 6. I move my lips when reading and count with my fingers.
_____ 7. I do not like to proofread my papers or look over my tests before I turn them in.
_____ 8. I prefer to do projects or make displays and presentations rather than write reports.
_____ 9. I think better when I have the freedom to move around; I get fidgety, feel trapped, and daydream when I have to sit still.
_____ 10. When I cannot think of a specific word, I will use my hands a lot and call something a “whatchamacallit” or a “thingamajig.”

_______ Total Tactile/kinesthetic
Learning Preferences

Visual Learners

Visual learners learn through seeing. These learners need to see the teacher's body language and facial expression to fully understand the content of a lesson. They tend to prefer sitting at the front of the classroom to avoid visual obstructions (e.g., people's heads). They may think in pictures and learn best from visual displays including: diagrams, illustrated textbooks, overhead transparencies, videos, flipcharts and handouts. During a lecture or classroom discussion, visual learners often prefer to take detailed notes to absorb the information.

Instructional recommendations include:

- viewing visuals such as bulletin boards, posters, transparencies, slides, videos, flashcards, television, pictures, graphs, etc;
- observing events such as dramatic presentations, role plays, demonstrations, experiments, community situations, animal behavior, etc.; and
- reading textbooks, comic books, pamphlets, posters, newspapers, bulletin boards, flashcards, reports, letters, maps, magazines, etc.
Auditory Learners

Auditory learners learn through listening. They learn best through verbal lectures, discussions, talking things through and listening to what others have to say. Auditory learners interpret the underlying meanings of speech through listening to tone of voice, pitch, speed and other nuances. Written information may have little meaning until it is heard. These learners often benefit from reading text aloud and using a tape recorder.

Instructional recommendations include:

- listening to radio stations, television, speeches, lectures, debates, discussions, concerts, interviews, audiotapes, video tapes, etc. and

- interacting/verbalizing through panels, debates, discussions, brainstorming, oral questions and answers, round robins, oral reports, etc.
Tactile/Kinesthetic Learners

Tactile/Kinesthetic learners learn through moving, doing and touching. They learn best through a hands-on approach, actively exploring the physical world around them. They may find it hard to sit still for long periods and may become distracted by their need for activity and exploration.

Instructional recommendations include:

• touching/feeling objects, textures, temperatures, weights, lengths/distances, pressures, etc.;
• using/doing games, experiments, physical activity, manipulatives, etc.;
• making or drawing diagrams, collages, mazes, scrolls, diaries, pictographs, models, timelines, foods, clothing, banners, graphs, etc.; and
• writing or copying problems, letters, shapes, words, etc.
Teaching Strategies for Math

Knowing the learning style preferences and strengths of your students allows you to tailor instruction for maximum effectiveness. However, there are several teaching strategies which should almost always be observed in a math classroom, even when instruction is tailored to particular student strengths. Those strategies are listed below:

- Avoid memory overload by assigning manageable amounts of practice work as skills are learned.
- Build retention by providing review within a day or two of the initial learning of skills.
- Provide supervision to prevent students from practicing misconceptions and “misrules.”
- Reduce interference between concepts or application of rules and strategies by separating practice opportunities until the discrimination between them is learned.
- Make new learning meaningful by relating practice of subskills to the performance of the whole task and by relating what the students have learned about mathematical relationships to what the students will learn next.
- Reduce processing demands by preteaching component skills of algorithms and strategies.
- Teach easier knowledge and skills before difficult ones.
- Ensure that skills to be practiced can be completed independently with high levels of success.
- Help students to visualize math problems by drawing.
- Give extra time for students to process visual information in a picture, chart, or graph.
- Use visual and auditory examples.
- Use authentic situations that make problems functional and applicable to everyday life.
- Do math problems on graph paper to keep the numbers in line.
- Use uncluttered worksheets to avoid too much visual information.
- Use rhythm or music to help students memorize.
- Use distributive practice: plenty of practice in small doses.
- Use interactive and intensive practice with age-appropriate games as motivational materials.
- Have students track their progress; which facts they have mastered and which remain to be learned.
- Challenge critical thinking about real problems with problem-solving.
- Use manipulatives and technology such as tape recorders or calculators.

Note: While these strategies are designed with the learning-disabled math student in mind, many of them are applicable to all learners.

Real Learning with Realia

Dianne B. Barber
2004 ABSPD Institute Participants

When students participate in real-life activities using authentic materials, they feel more engaged, successful, and comfortable expanding their skills outside the classroom.

_Literacy Practices of Adult Learners_
Overview

Realia is any authentic material or activity that relates to students’ background, knowledge, and real life, i.e., materials that naturally exist in their daily lives. Instructors often do not have time to develop authentic materials and may have little experience using realia. At the same time, students need practice in math, communication, and critical thinking skills that will enable them to become full participants in society.

This professional development plan provides opportunities for participants to learn practical strategies for implementing simulated real-world experiences in the classroom. It includes activities instructors can adapt for varied levels of students’ needs in one-on-one, small group, or classroom settings.

Goal

The goal of this plan is to provide professional development using research-based methods, strategies, and techniques for using realia to enhance math instruction, communication, and critical thinking skills.

Objectives

Participants will

- identify the benefits of using realia;
- demonstrate techniques for teaching identification of money;
- identify basic banking terminology;
- demonstrate the correct use of a checkbook; and
- use fractions, decimals, and percents in a simulated real-world setting.
Summary of Activities

<table>
<thead>
<tr>
<th>Activity</th>
<th>Materials</th>
<th>Time</th>
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<tbody>
<tr>
<td><strong>Activity 11.1: Teaching with Realia</strong></td>
<td>Box of realia items, flip chart, and markers.</td>
<td>60 – 90 minutes</td>
</tr>
<tr>
<td><strong>Activity 11.2: Know Your Money</strong></td>
<td>Play money and money symbols, see preparation for how to make</td>
<td>30 – 45 minutes</td>
</tr>
<tr>
<td><strong>Activity 11.3: Checking Accounts</strong></td>
<td>“Math Spelling for Check Writing” and “Banking” handouts; copies of checks, deposit slips, and transactions registers; flip charts; and markers.</td>
<td>30 – 45 minutes</td>
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<tr>
<td><strong>Activity 11.4: Comparison Shopping</strong></td>
<td>“Sale Advertisements” handout, flip charts, and markers.</td>
<td>30 – 45 minutes</td>
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<tr>
<td><strong>Activity 11.5: Shop ‘Til You Drop</strong></td>
<td>“Shopping Spree” handout, variety of sale papers and menus, and calculators</td>
<td>60 – 90 minutes</td>
</tr>
</tbody>
</table>

Authors

This topic includes excerpts of professional development plans submitted by the following Institute 2004 participants.

Wanda Harding, Burnsville Elementary School
Janis Holden-Toruño, Fayetteville Technical Community College
Ron Liggins, Fayetteville Technical Community College
J. Robert Moore, Nash Community College
Pauline Morris, Forsyth Technical Community College
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Kelly Norton, Literacy Council of Union County
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Frances Thomas, Robeson County Church and Community Center
Cynthia M. Worth, Piedmont Community College
Activity 11.1: Teaching with Realia

What is realia? Many Adult Basic Skills instructors are not familiar with the term. This activity is designed to enhance participants’ knowledge of realia and discuss some of the benefits of using realia as a teaching tool.

Preparation

1. Make a “Realia Box.” Begin with some type of container, i.e., cardboard box, plastic crate, etc. Collect items to put in the “Realia Box.” Put two of each item in the box. You will need to have enough items for each participant to choose one. Suggested items include:
   - rulers,
   - tape measures,
   - measuring spoons and cups,
   - cookbooks,
   - thermometers,
   - protractors,
   - maps,
   - restaurant menus with prices,
   - newspapers,
   - watches or clocks,
   - credit card statements,
   - charts,
   - graphs,
   - invoices,
   - play money,
   - calendars
   - forms where numbers are used, or
   - any other items adults may use in daily life.

   Be creative. Be sure to remove names, account numbers, and any other identifying information from documents.

2. At the beginning of the activity, display the items from the “Realia Box” on a table. Place table so participants can easily choose and pick-up an item.

3. Have flip charts and markers available.
Conducting the Activity

1. Begin by asking participants to explain what the term “Realia” means. List comments on the flip chart and hang the paper on the wall. Sum up comments with a statement such as, “Realia is any authentic material or activity that relates to students’ background, knowledge, and real life, i.e., materials that naturally exist in their daily lives.”

2. Participants choose an item from the display table.

3. Ask participants to find a person who has the same item. Advise participants that they will be working as partners with the person who has the same item.

4. Challenge participants to brainstorm and list the ways they could use their items as a tool to teach math for multi-level students, i.e., beginning level, compensatory education, higher-level, ESL, etc. You may want to target levels based on those taught by participants.

5. Ask each pair to choose one idea and write a mini-lesson plan.

6. Give participants flip charts and markers to use for outlining their lesson plan.

7. Ask participants to briefly share their brainstorm list and demonstrate the lesson plan(s) they wrote. Allow time for group interaction, i.e., add other ideas about how to use the realia item to teach additional math concepts. Note: You may want to have a note taker to record ideas and supply participants with a handout of the ideas generated.
Activity 11.2: Know Your Money

Beginning level Adult Basic Skills students need basic arithmetic skills, specifically as applied to money. Adults deal with money on a daily basis. Counting money is a basic survival skill. Students must know how much money they have, how much items cost, and how much change they should get back from purchases. This activity is designed to demonstrate techniques that may be used to teach beginning level students to identify money by name and value, to identify the symbols used in monetary notation, and to count money.

Preparation

1. Get a supply of play money, both bills, and coins or use real money.

2. Make operation symbols (+, −, and =). Cut small squares of card stock. Use a marker to place one symbol on each square. Make enough so that each participant can have two of each symbol or plan for participants to make their own set.

Conducting the Activity

1. Demonstrate how to teach beginning level students about money using participants as students.

2. Using coins and paper bills for illustration, demonstrate how to teach money names and values (e.g., show that five pennies equal one nickel, 10 pennies equal one dime, 100 pennies equal one dollar, etc.)
3. Conduct a drill with participants asking questions such as “What’s this?” (holding up a piece of money) and “What is it worth?” Illustrate that there’s often more than one correct answer.

4. Give each participant some money. Demonstrate how to quiz students on simple mental addition by asking participants to, “Show me 35 cents,” “Show me 50 cents,” etc. Ask participants to show how many different ways they can make 25 cents, 35 cents, etc.

5. Using examples of written numbers ($1.36, $.21, etc.), explain the dollar sign ($), the decimal (.), and the cent sign (¢). Explain that there are two ways to write a monetary number 99 cents or less, i.e., $.99 and 99¢. Also mention that the cent sign is no longer on computer keyboards.

6. Use the operation symbol manipulatives, i.e., +, -, and =. Ask participants to perform several addition and subtraction problems using money, i.e., show one dime “+” one nickel “=“ one dime and one nickel. Progress into more difficult problems, i.e., 3 quarters – 2 dimes = 2 quarters and one nickel. Use the actual money pieces, not the numerals. As participants make “money” equations ask them to write on paper the correct symbolism for the equation using dollar signs, decimals, and cent signs as appropriate.

7. Compare adding numbers to adding money. Advise participants the importance of making this connection with students. “As instructors we must help students make the leap from adding numbers to adding money. Start by showing students that the 5 becomes $5.00 by simply adding the .00 and $ to any numbers. The number 25 becomes twenty-five cents by adding 25¢ or $.25.”

8. Inform participants that students must be taught that the dollar signs, decimals, and cent signs must always line up. You may draw lines between the rows to provide a visual. Allow participants to practice turning some regular addition problems into money addition problems, i.e., $3.00 + $5.00 =
$8.00. Next allow participants to add dollars and cents. All problems should contain simple addition that does not contain carrying and borrowing; these skills may not have been taught to beginning level students.

9. Remind participants that subtraction is addition reversed. With this in mind, provide participants with several simple subtraction problems to convert to simple subtraction problems using money.

10. Reflect on the activities completed. Allow participants to share strategies they have used to teach beginning level students about money.
Activity 11.3: Checking Accounts

Checking accounts are a way of life for many, yet some Adult Basic Skills students have had little or no exposure to maintaining a checking account. This activity is designed to demonstrate instructional strategies that may be used to teach beginning level adult students to write checks, fill in deposit tickets, and maintain a transaction register.

Preparation

1. Make copies of the “Math Spelling for Check Writing” and “Banking” handouts.
2. Make “checking account packets” for each participant. Each packet should include
   a. 9 checks,
   b. 3 deposit slips and
   c. 1 transaction register.
3. Have additional checks, deposit slips, and transaction registers available.
4. Have flip chart and markers available.

Conducting the Activity

1. Brainstorm ways checks can be used. Discuss checks versus cash. Why should or should not a person need/want a checking account? List responses on board or flip chart.
2. Break into small groups. Participants discuss and list experiences they have had with checking accounts; ask participants to list fears they have (or have had) about them.
3. Give participants a copy of the “Math Spelling for Check Writing” handout. Advise participants that this handout is a great tool when working with beginning level students. Discuss how it may be used in the classroom.

4. Distribute “checking account packets.” Demonstrate how to teach the different parts of a check, a deposit slip, and the transaction register. For example: Let’s look more closely at a check. A check has 6 important parts. How many can we name?” (Write items on board.)
   a. Date
   b. Person or business you are paying (payee)
   c. Amount in words—write the number of cents over 100 as shown
   d. Amount in numbers
   e. Your signature
   f. Reason for the check

5. Complete similar activity for the deposit slip and the transaction register.

6. Demonstrate how to write a check, fill out a deposit slip and record banking transactions in the register.

7. Distribute the “Banking” handout. Participants follow instructions on the handout to complete simulated bank transactions.
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Checks

Willie Barker or Clara Sue Barker  No: ___________
Barker Street  
Hill City, NC 22222

DATE________________________

PAY TO THE ORDER OF ____________________________ | $ ____________________________

Hill City Bank
Hill City, NC 22222

FOR __________________________________________________________

Willie Barker or Clara Sue Barker  No: ___________
Barker Street  
Hill City, NC 22222

DATE________________________

PAY TO THE ORDER OF ____________________________ | $ ____________________________

Hill City Bank
Hill City, NC 22222

FOR __________________________________________________________

Willie Barker or Clara Sue Barker  No: ___________
Barker Street  
Hill City, NC 22222

DATE________________________

PAY TO THE ORDER OF ____________________________ | $ ____________________________

Hill City Bank
Hill City, NC 22222

FOR __________________________________________________________
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<td><strong>Hill City Bank</strong></td>
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<tr>
<td><strong>Hill City, NC 22222</strong></td>
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<tr>
<td><strong>Subtotal</strong></td>
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<tr>
<td><strong>Less Cash Received</strong></td>
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</tbody>
</table>
## Transaction Register

<table>
<thead>
<tr>
<th>CHECK NO.</th>
<th>DATE</th>
<th>DESCRIPTION OF TRANSACTION</th>
<th>PAYMENT/DEBIT (-)</th>
<th>DEPOSIT/CREDIT (+)</th>
<th>$ BALANCE</th>
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</thead>
<tbody>
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</tbody>
</table>
Banking

Below is a list of 10 bank transactions. Put entries for these transactions in the correct places. Fill out deposit slips and write checks as needed. Remember to record all deposits and checks in the Transaction Register.

1. Willie and Clara Sue Barker opened a new checking account at the Bank of Hill City on November 14. They deposited Willie’s earnings from the Big Max Trucking Co. Willie’s check was in the amount of $995.00. Clara Sue’s check was from the Super K-Mart in the amount of $365.00.

2. On November 16, Willie sat down to pay bills. Willie wrote check number 0001 for rent in the amount of $425.00 to Hill City Apartments. Willie also wrote check number 002 to Maximum Cable for cable TV in the amount of $49.88.

3. On November 17, Clara Sue bought groceries that cost $78.23 at the local Smith Boys’ Grocery and paid with check number 003.

4. The electric bill came the next day and Clara Sue paid all $105.58 by writing a check to Boss Power and Light with check number 004.

5. For the Bakers 10th wedding anniversary on November 20, Willie took Clara Sue to Red Lobster for dinner and paid by check in the amount of $32.45. He used check number 005.

6. Clara Sue makes beautiful quilts that she sells at a local craft store on consignment. One of the quilts sold for $200, and the craft store sent her a check. Clara Sue deposited this money on November 21.

7. Willie went to the Riverside Fish and Tackle Store and bought $350 worth of fishing equipment for his upcoming fishing trip with the guys. He paid for it with check number 006. It was the 22nd of November.

8. Willie then went to Big Hill Motorboats, Inc. and made a down payment of $300 on a boat. He paid by check number 007 on November 22.

9. On November 28 the bank statement came. Clara Sue opened the statement. The service charge was $4.00. Clara was upset, but it wasn’t because of that charge. She looked at the balance and reviewed checks written. When Willie got home, they had a big fight.

10. Check number 008 was written on November 29, to Thrifty Marriage Counseling in the amount of $75.00.
Activity 11.4: Comparison Shopping

Sales provide unlimited opportunities to explore and develop mathematical reasoning skills. Math lessons that involve shopping usually generate interest and involvement, thus giving life to mathematical skills and knowledge.

Preparation

1. Make copies of the “Sale Advertisements” handout for each participant or use sale papers that advertise similar items.
2. Be sure to have access to a white board or flip chart paper and markers.

Conducting the Activity

1. Ask participants if they have ever purchased something at “a good price,” only to find out later that they could have bought it for less elsewhere. Participants describe their experiences.
2. Distribute the “Sale Advertisements” handout or real advertisements. Ask participants to analyze the two advertisements for the same product and decide which store offers the best buys.
3. Once participants have decided on the store offering the best buy lead a discussion on why they chose one store over another. Conclude that price, convenience, and personal preferences play a role in smart shopping. You might point out that it often helps to see, and, where possible, test a product before buying it. Remind participants to think about hidden expenses, such as the cost of traveling to stores in remote locations.

Sale Advertisements

Danny’s Bicycle Shop
Best Bike Buys
Open 10-5 Monday – Saturday

MONGOOSE 24” Silver Dirt Bike   $189
26” SCHWINN 10-speed Electric Blue   $225
Helmets with Bike Purchase   $30
Spare Tires for 10-speeds $25

Buy a MONGOOSE this month and get FREE reflectors.
FREE horns for children with all A’s on report cards.
LOW PRICES on Big Wheels, Trikes, and Wagons.

Directions: Take Highway 66N 10 miles, turn East on RT 128 for 15 miles, take the right fork, go eight miles, Danny’s is on the right.

DOWNTOWN BIKES
EVERY DAY IS SALE DAY!

SCHWINN 10-SPEEDS
with helmet
$265

MONGOOSE DIRT BIKES
with helmet & reflectors
$220

ONE-YEAR WARRANTY ON PARTS, LABOR, AND SERVICE.

FREE Bike Safety Book
with Bicycle Purchase

OPEN DAILY
10 AM TO 9 PM

LOCATED IN THE HEART OF DOWNTOWN
Activity 11.5: Shop ‘Til You Drop

Math activities can and should be fun. The idea of winning a shopping spree appeals to almost everyone. Many types of math calculations are required when shopping sales.

This activity allows participants to go on a pretend shopping spree and then to develop a shopping spree lesson plan. Participants will encounter sale items, sales tax, and restaurant tipping. Participants will use fractions, decimals, percents, and proportions to total a final amount spent at the end of the shopping spree.

Preparation

1. Make copies of the “Shopping Spree” handout, one for each participant.
2. Collect a variety of sale papers and menus. Make team packets that include one of each sale paper and one of each menu. Plan for participants to work in teams of 3 or 4.
3. Have calculators available.

Conducting the Activity

1. Review fractions, decimals, percents, and proportions. Then ask participants to work with you to complete the following problem. You may need to demonstrate how to use the required functions on the calculator.

A bicycle cost $125. It has been marked down 30%. How much was it marked down? What is the new price? If there is a 7% sales tax, what is the total cost? You only have enough money to
pay 80% of the total cost (tax included) on the bicycle. How much money do you have today and how much money do you still owe?

2. Give each participant a copy of the “Shopping Spree” handout. Briefly explain the activity. Let participants know they may work with a partner to complete the activity.

3. Divide participants into small groups.

4. Each group develops a lesson plan for a simulated shopping spree. You may want different groups to plan shopping sprees for different level learners, i.e. beginning level, intermediate level, etc.

5. Hand out newspaper flyers and restaurant menu packets.

6. Explain the items you want participants to consider in their lesson planning, such as:
   a. total amount they have to spend;
   b. may purchase only sale items;
   c. sales tax must be included on all purchases,
   d. must have lunch;
   e. restaurant experience should include food, tax, and tip;
   f. must remain within specified budget; and
   g. how payment will be made, i.e. checks, cash, credit card or a combination.

7. Participants share their lesson plan with the large group.

8. Optional Activity: Give participants a budget amount for buying a used car. Using newspaper classifieds challenge participants (individually or in small groups) to find the best used car for the money. Afterwards, participants compare choices and present arguments as to why the car they chose was the best.
Shopping Spree

**Directions:** Your best friend entered your name in a drawing for a $2,000 shopping spree at the Mall. After winning the drawing you went to Belk, Radio Shack, and Sagesport and purchased the items listed below. Afterwards, you ate at Tucker’s Restaurant. Calculate the amount of money you spent for the entire day. (Remember to include 7% sales tax on all purchases.) Show how you arrived at the total amount spent.

**Belk**
- $55 pair of jeans at 30% off.
- $42 pair of shoes at half off.
- $25 bottle of perfume/cologne at 15% off.
- $300 down comforter at 30% off with an additional 50% taken off at the register.

**Radio Shack**
- $99 cell phone at 25% off.
- $1,695 laptop at 20% off.
- $300 printer at 50% off with the purchase of any laptop.

**Sagesport**
- $95 hiking boots for only 1/4 the original price.
- Two basketballs at $14 each or buy one basketball and get a second at 1/2 price.
Tucker’s Restaurant

- Chili Cheeseburger $3.50
- Cheese Fries $2.50
- Coke $1.50
- Chocolate Cake $2.50
- 18% tip

Points to Ponder

- How much did you spend at Belk?
- How much did you spend at Radio Shack?
- How much did you spend at Sagesport?
- How much did you spend at Tucker’s?
- What was your total amount spent?
- Did you stay within the given budget? By how much were you over/under?
Projects to Enhance Learning

Dianne B. Barber
Janis M. Holden–Toruño

In its simplest form, project-based learning involves a group of learners taking on an issue close to their hearts, developing a response, and presenting the results to a wider audience.

Wrigley
Overview

Using project-based learning can create a classroom environment where students form powerful learning communities focused on contribution, achievement, and self-mastery. Additionally, project-based learning integrates skills across the curriculum, i.e., students read, write, research, communicate, calculate, etc. The focus of this professional development plan is to provide exposure to project-based learning and ideas for class projects.

Goals

The goal of this plan is to provide professional development using research-based methods, strategies, and techniques for using project-based instruction to enhance learning.

Objectives

Participants will

• define project-based learning;
• identify the benefits of project-based learning;
• participate in a learning project; and
• identify project for use with students.
### Summary of Activities

<table>
<thead>
<tr>
<th>Activity</th>
<th>Materials</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Activity 12.1:</strong> What is Project-based Learning?</td>
<td>Chapter 7: Project-based Teaching and Learning, flip charts, and markers</td>
<td>45 - 60 minutes</td>
</tr>
<tr>
<td><strong>Activity 12.2:</strong> The Developing Country</td>
<td>“Developing Country Budget” and “Programs” handouts, flip charts or poster board, paper, markers, and glue sticks</td>
<td>60 - 90 minutes</td>
</tr>
<tr>
<td><strong>Activity 12.3:</strong> Classroom Makeover</td>
<td>flip charts, markers, calculators, measuring tapes, advertisements for carpet, padding, tile, paint, wallpaper, ceiling tiles, etc., and labels or sample paint cans, wall paper, etc.</td>
<td>60 - 90 minutes</td>
</tr>
</tbody>
</table>
Activity 12.1: What is Project-based Learning?

Through project-based learning, students are encouraged to become collaborative and independent workers, critical thinkers, and lifelong learners. Project-based learning is a way of working together. The focus of this activity is to enhance participant knowledge about project-based teaching and learning.

Preparation

1. Divide Chapter 7: Project-based Teaching and Learning into 4-6 small sections. Make copies so that each participant will have a copy of a section.
2. Have flip charts and markers available.

Conducting the Activity

1. Divide participants into groups.
2. Assign a section of the chapter to each group. Give each group member a copy of the assigned section.
3. Each group reads and discusses its assigned section.
4. Participants jigsaw into new groups, i.e., one member of each group forms a new group.
5. Participants share the information from the first group.
6. Discuss. What are the benefits of project-based learning in the Adult Basic Skills classroom? Brainstorm possible projects; list on flip chart paper.
7. Allow participants to experience project-based learning by completing another activity from this chapter.
Activity 12.2: The Developing Country

Nations are faced with numerous options when it comes to the distribution of the limited resources and events that could lead to their successful development or ruin. In this simulation, participants make decisions, allocate resources and consider how those decisions might impact the country’s development.

Preparation

1. Make copies of “Developing Country Budget” and “Programs” handouts for each participant.
2. Have flip charts or poster paper, paper, markers, and glue sticks available.

Conducting the Activity

1. Divide participants into teams (3-5 people).
2. Have teams develop an imaginary country. They need to select a name, make a flag, and choose a form of government. Do not tell the students anything further at this point.
3. Distribute and briefly explain the “Developing Country Budget” and “Programs” handouts.
4. Participants create a budget for their country based on the handout information.
5. Participants prepare a chart, graph, table, and/or diagram showing their budget allocations for their imaginary country.
6. Each team explains their budget and reasons for allocating money to the various areas.
7. Discuss and debrief. Did any teams add new programs? Do the amounts allocated make sense according to the country’s characteristics? What was learned? Did the activity relate to the real world? Can the situations be applied to your own life? What was the learning process? the math skills involved?, etc.
Developing Country Budget

Your situation.

Your group is composed of people with degrees in economics and finance. You have formed a consulting firm and your first client has approached you for advice. Your firm will receive a large fee and a great deal of prestige if you are able to assist your new client.

Who is your new client?

Your client is the government of the country whose flag and name you have just developed. It is an underdeveloped country in Asia. It has a population of 2,500,000 people and an area of 25,000 square miles.

For many years, the world has ignored this poor, illiterate country. The situation has recently changed because oil was discovered and oil revenues are projected to be 50 billion dollars for the next year and for each year after that for the next ten years.

The government has asked your firm to decide how much money should be budgeted for each of the programs it wants to undertake. There is a list of proposed programs, but your firm may add additional programs as the budget allows.

Your Mission

Decide what percentage of the budget should be given to each of these programs. How much is each percentage in actual dollars? Make a poster, chart, diagram, and/or table to present your new budget.
Programs

Program 1: Military Defense

Your country has an army of 5,000 men. There are no modern weapons to defend your country from neighbors who might want to take over your oil fields.

Program 2: Communications

Only the capital city has telephone service. Fewer than 50,000 homes have telephones. There is no cellular service and getting on the Internet is virtually impossible. There are no television stations in your country. A few wealthy people who have traveled out of the country have satellite dishes and can pick up programs, but over 98% of the public has never seen television.

Program 3: Education

Your country has a literacy rate of only 11%. Of the 11% who can read, more than half have only finished the equivalent of sixth grade. Less than 1% of the population has a college degree. There are no universities in your country and the only high schools are in the capital.

Program 4: Transportation

Your country has one major airport and two smaller airports. There is one railroad that links both sides of the country, but the tracks are a different gauge from the neighboring countries. If you want to travel out of the country by rail, you have to get off the train near the border and walk about one mile before you get to the train station at the neighboring country. Most roads are unpaved.
Program 5: Utilities

Electricity is virtually non-existent in the smaller cities and in the rural areas. The only places with electricity in these areas are those that have portable generators. Outside of the capital, only the wealthy people and some hospitals have refrigerators, stoves, or electric lights. Even in the capital, electricity is not always available.

Program 6: Agriculture

Your country’s people suffer from malnutrition. Rice is the main food eaten, but due to a drought, the production of rice is very low this year. (Rice needs a great deal of water to grow). Additionally, chickens and other farm animals have died from the lack of water. Your people don’t understand the basics of a balanced diet. Because of the drought, they are no longer self-sufficient. They need food from other countries. The country can afford to pay for the food, but getting it to the people and helping them understand their nutritional needs are problems.

Program 7: Tourism

Your country is in a beautiful area of Asia. Despite the drought, there are still many interesting things to attract tourists. Foreign investment could come to your country if enough tourists are attracted. However, there is only one hotel in the capital, and it is not very attractive. There are few restaurants. There is no tourist industry now, so tourism would have to be developed.

Program 8: Medical Services

There is only one doctor for every 50,000 people, and the hospital in the capital city is not very modern. At least the hospital in the capital is better than the so-called hospitals in the rest of the country.
Program 9: Recreation and Arts

Your country’s citizens have little opportunity to escape the dreariness of their everyday lives. There are no theaters or sports arenas. There are only three movie theaters in the capital, and they never show modern releases. Children do not learn about the arts in school because most children do not attend school. The country lacks stimulating activities for its citizens.

Program 10: Industry

Your country’s oil will not last forever. Experts believe that the oil supply will dry up within 35 years. Currently there is no industry on which to base its future economy. If industry were attracted to your country, the citizens could learn new skills and gain employment. They would have a future for their country once the oil runs out.

Program 11: Administration

With only 18,000 people having college degrees, your country needs to hire outsiders to administer its affairs. The current leader does not understand economics very well, although he is interested in protecting his people and seeing them prosper.

Program 12: Technology

The only computers in your country are those brought in by visitors or owned by the wealthy. Only the president and a few chosen people have email since Internet access is only possible through an expensive satellite link system. All record keeping, tax collecting, budgeting, and other activities that the United States government does by computer is done manually in your country. This takes time and is not always accurate.

Activity 12.3: Classroom Makeover

This activity allows participants to experience the math involved in a simulated classroom makeover.

Preparation

1. Have available flip charts, markers, calculators, and measuring tapes.
2. Collect advertisements for carpet, padding, tile, paint, wallpaper, ceiling tiles, etc., and labels or sample paint cans, wall paper, etc.

Conducting the Activity

1. Ask participants what home or yard improvement project they have done. List on flip chart. Discuss the math involved in each project, i.e., measurement, area, perimeter, volume, cost, etc.
2. Explain that as teams they are to write a proposal for a classroom makeover.
3. Divide the participants into 8 groups, 2 groups work independently on the same assignment. Groups will take measurements, determine how much product is needed, the cost of the product, the best product to use, and justify their decision. Assignments are as follows:
   a. Floor—carpet or tile
   b. Walls—paint or wallpaper
   c. Ceiling—paint or ceiling tiles
   d. Windows—drapes or blinds
4. Participants outline their proposal on a flip chart.
5. Participants share and compare their proposals.
6. Reflect on the activity. Is it appropriate for basic skills students?
Chapter 13

Teaching Multi-level Learners

Dianne B. Barber
2004 ABSPD Institute Participants

Learners should be able to develop the skills common to them all, using the interests, the materials, and the activities that most closely match their needs.

A Fresh Start
Overview

Most instructors work with a diverse group of students ranging in age from teenagers to senior citizens. These students bring with them a variety of emotional, economic, and social needs, as well as varying learning styles and academic levels. Teaching these students on a one to one basis is an overwhelming experience. Having an open enrollment policy adds another layer of complication for planning.

For instructors to meet the math needs of all students, it is necessary to develop learning experiences and activities that include large group, small group, paired and individual instruction. This professional development plan focuses on enhancing the knowledge of instructors who teach in multi-level classrooms.

Goals

The goal of this plan is to provide professional development using research-based methods, strategies, and techniques to equip instructors with a working knowledge of various strategies, methods, and resources for teaching multi-level learners.

Objectives

Participants will

- develop a working definition of multi-level learning;
- identify and understand at least three strategies that are useful in multi-level learning;
- list advantages and disadvantages of multi-level teaching strategies; and
- develop a lesson plan using a new strategy.
### Summary of Activities

<table>
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<tr>
<th>Activity</th>
<th>Materials</th>
<th>Time</th>
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<tbody>
<tr>
<td><strong>Activity 13.1: Multi-level Class Role Play</strong></td>
<td>A mini classroom set up at the front of the training room.</td>
<td>30 - 45 minutes</td>
</tr>
<tr>
<td><strong>Activity 13.2: What is Multi-level Learning?</strong></td>
<td>“Accommodate the Multi-level Classroom” handout, flip chart paper, and markers</td>
<td>30 - 45 minutes</td>
</tr>
<tr>
<td><strong>Activity 13.3: Multi-level Teaching Strategies</strong></td>
<td>“Demonstration,” “Small Group,” “Project-based,” and “Educational Games” handouts; flip chart paper; and markers.</td>
<td>60 - 90 minutes</td>
</tr>
</tbody>
</table>

### Authors

This topic includes excerpts of professional development plans submitted by the following 2004 ABSPD Institute participants.

Paula Battle, Lenoir Community College  
Bill Edwards, Central Carolina Community College  
Madalene Hardison, Wayne Community College  
Curtis Hildt, Coastal Carolina Community College  
Katrina Hinson, Lenoir Community College  
Joyce Jarrard, Appalachian State University  
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Fabrienne Kittrell, Lenoir Community College  
Stephanie Light, Craven Community College  
Howard Lovingood, Tri-County Community College  
Karen McAlister, Stanly Community College  
Ed Mercer, Central Carolina Community College  
Beth Throneburg, Stanly Community College  
Lynne Toepke, Coastal Carolina Community College  
Brian Wagoner, Fayetteville Technical Community College
Activity 13.1: Multi-level Class Role Play

Facing the demands of teaching in a multi-level classroom requires the instructor to multi-task from the time they enter the classroom. Not only must the instructor work with differing academic levels and learning styles, they must also be ready to admit new students, give practice tests as needed, and give individual attention to students.

Opening the training session with a short role-play that depicts a multi-level classroom allows participants to observe and identify some of the common problems that instructors face on a daily basis.

Preparation

1. Review and/or become familiar with the diversity that may occur in a multi-level class.
2. Decide how many people will have active parts in the play; i.e., instructor and several students with varying academic backgrounds such as beginning level, pre-GED, GED, adult high school, and compensatory education.
3. Prepare a description of the personality for each person represented in the play.
4. Ask participants to play the different parts the day of training or prior to the training. The activity may run smoother if you select participants and practice prior to the actual training.
5. Set-up a mini classroom at the front of the training room, i.e., a table with chairs for the “students” or desks for each.
Conducting the Activity

1. Ask several volunteers to act as students in a role-play. You will need students in each of the following categories: beginning level, pre-GED, GED, adult high school, and compensatory education.

2. Explain to participants their roles, i.e., their assigned personality and level. Have them model what they have seen in class. Be creative.

3. Role-play a typical multi-level classroom by teaching a 15-minute segment to the “students” as they play their assigned roles.

4. After the play, facilitate a discussion about what participants observed.
Activity 13.2: What is Multi-level Learning?

Instructors need a clear understanding of the definition and parameters of multi-level teaching and learning. Sharing ideas with others develops and refines those understandings.

Preparation

1. Put each of the following questions on flip-chart paper, transparencies, or PowerPoint slides. Put one question per page or slide.
   a. What is your definition of “multi-level learning?”
   b. What are some characteristics of multi-level learning?
   c. What do you see as advantages and/or disadvantages of multi-level classrooms?

2. Make copies for each participant of the “Accommodate the Multi-level Classroom” handout.

3. Have flip charts and markers available.

Conducting the Activity

1. Ask participants to write answers to each of the following questions. Display the first question, read it aloud and allow about 1 minute for the participants to write their response. Repeat for each question. Questions:
   a. What is your definition of “multi-level learning?”
   b. What are some characteristics of multi-level learning?
   c. What do you see as advantages and/or disadvantages of multi-level classrooms?

2. Participants choose partners and compare and contrast their ideas. Allow approximately five minutes for pair sharing.
3. Pairs merge into small groups (4-8 per group), share responses, and as a group decide on the best answer for each question.

4. Groups list their answers on the flip chart.

5. Groups share their responses. Put the flip chart papers on the wall.

6. The larger group compares and contrasts answers and generates questions and discussion.

7. Give each participant a copy of the “Accommodate the Multi-level Classroom” handout. Within their small groups ask participants to discuss each item on the handout and brainstorm other items they feel should be added to the handout.

8. A member of each small group presents a summary. Allow participants to generate discussion.
Accommodate the Multi-level Classroom

- Flexible format of teaching—incorporating new, out-of-the-box ideas
- Topic driven teaching versus ‘skill’ repetition
- Non-text dependent
- Allow a range of learning
- Accept silence
- Solidify the learning community by learning the differences/similarities of students
- Clarify realistic goals
- Encourage students to take responsibility for their own learning
Activity 13.3: Multi-level Teaching Strategies

There are several approaches to teaching in a multi-level classroom, and each has possible application in certain situations. By sharing rationales for choosing or not choosing a given strategy for multi-level classroom teaching, participants become more astute at choosing from available strategies.

Preparation

1. Make copies of the “Demonstration,” “Small Group,” “Project-based,” and “Educational Games” handouts.

2. Identify several topics that may be taught in a typical Adult Basic Skills multi-level classroom, i.e., telling time, reducing fractions, shopping, money, etc. You will need one topic for every 4 to 6 participants expected.

3. Have flip charts and markers available for each group.

Conducting the Activity

1. Randomly divide participants into groups of 4 to 6. Participants might count off; all the one’s in a group, two’s in a group, three’s in a group, four’s in a group, etc.

2. Assign a strategy (Demonstration, Small Group, Project-based, and Educational Games) to each group. Give each participant within the group a copy of the handout for the groups’ assigned strategy.

3. Assign a topic for each group.

4. Ask each group to review the advantages and disadvantages of their assigned strategy and to develop a lesson plan for a multi-level classroom using their assigned strategy and topic.

5. Ask each group to present a brief summary of their strategy and their lesson plan to the larger group. Allow time for discussion and questions.
Demonstration

**Advantages**
- Allows observation of the task being performed
- Gives students a step-by-step approach
- May be live or videotaped
- Provides visual instruction as well as auditory and possibly tactile
- No background information needed
- May involve participants
- May provide hands-on experience

**Disadvantages**
- Instructor may be poor “model”
- Difficult for large groups
- Must be a simple process
- Takes a lot of time
- Pre-existing knowledge can spoil demonstration
- Practice may be limited
Small Group

Advantages

➢ Allows integration of critical thinking and other language processes, i.e., talking, listening, writing, and reading
➢ Permits expansion of repertoire of learning strategies by creating opportunities for learners to experience and observe the learning of others,
➢ Breaks down isolation and stigma experienced by adults with insufficient literacy skills and provides peer support for their learning
➢ Enhances learners’ self-esteem by helping them understand that they have much to offer as a result of their experiences
➢ Makes available a wide range of resources, including the thinking skills, experience, help, and encouragement through the collective expertise of the group members
➢ Eases the distinction between teachers/tutors and learners by creating a cooperative, participative environment that is less hierarchical than those produced by traditional approaches

Disadvantages

➢ Accommodating a wide range of needs (conflicting goals, different learning rates, etc.) and abilities is difficult
➢ Needs of individuals in a group have to be reconciled with the needs of the group thus tension may arise between learner-centeredness and group-centered
➢ Negotiating a learner-centered curriculum can be hard work
➢ Requires more preparation time than one-on-one tutoring
➢ Some learners are simply not comfortable with the idea of group participation
➢ Facilitator needs group leadership skills in addition to teaching skills
Project-based

Advantages
- Engaged in a real world project
- Identify what they need to learn to complete the project
- Inspired to cooperate and help each other learn
- Enjoy learning

Disadvantages
- Requires a large time investment
- Difficult to adapt for group members who enter class after project begins or who do not continue until the end
- Some important learning needs may not be addressed by selected topics
- May divide learning requirements and fail to share procedures they learned
Educational Games

Advantages

➢ Increases the understanding of principles
➢ High student involvement
➢ Fun, interesting way to teach
➢ Interactive
➢ Ability to use with a large group
➢ Games often involve problem solving strategies
➢ Improves retention

Disadvantages

➢ May have “lazy” participants
➢ May be viewed as “childish” by participants
➢ Possibility for too much competitiveness
➢ Requires significant time investment to make/find games
Fun with Beginning Math

Dianne B. Barber
2004 ABSPD Institute Participants

Do math and you can do anything.
N.C.T.M. slogan
Overview

Many students come into our Basic Skills classroom believing math is hard and impossible to learn. This belief stifles students in their quest to acquire basic math skills. This professional development plan offers games and creative activities that can be used to promote confidence while enhancing students’ math and thinking skills. These games also allow students to develop team building and communication skills. Participants will gain concepts moving instructors from the traditional textbook approach to hands-on learning.

Goal

The goal of this plan is to provide professional development using research-based methods, strategies, and techniques to give instructors new ways to demonstrate and review mathematical concepts using games and manipulatives.

Objectives

Participants will

- learn methods and strategies for teaching beginning level math students in math, and
- engage in hands-on math games and activities that enrich math and thinking skills.

Summary of Activities

Many games and activities are included in this plan. Unless a series of professional development workshops are planned, trainers need to choose from among the activities listed. As well as
being the main focus of a workshop, these activities are good for opening, closing, or after-break activities for any math workshop. Activities 2-8 are written for the classroom thus providing detailed instructions for conducting them with students. As the trainer, adjust as necessary for your participants’ backgrounds and knowledge of the mathematical concepts.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Materials</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Activity 14.1: Scavenger Hunt</td>
<td>Trainer made “Scavenger Hunt” handout</td>
<td>10 - 20 minutes</td>
</tr>
<tr>
<td>Activity 14.2: Three-in-a-Row</td>
<td>“Three-in-a-Row Game Board” handout, dice, and game markers</td>
<td>15 - 30 minutes</td>
</tr>
<tr>
<td>Activity 14.3: Rounding in a Row</td>
<td>“Rounding in a Row-Addition” and “Rounding in a Row-Multiplication” handouts, game markers, and calculators</td>
<td>15 - 30 minutes</td>
</tr>
<tr>
<td>Activity 14.4: Beach Ball Math</td>
<td>Prepared beach ball, see activity for directions</td>
<td>5 - 10 minutes</td>
</tr>
<tr>
<td>Activity 14.5: Magic Fingers</td>
<td>none</td>
<td>5 - 10 minutes</td>
</tr>
<tr>
<td>Activity 14.6: I have, Who has…</td>
<td>Prepared decks of cards, see activity for directions</td>
<td>10 - 20 minutes</td>
</tr>
<tr>
<td>Activity 14.7: Playing Cards to Learn Math</td>
<td>Deck(s) of playing cards</td>
<td>10 - 20 minutes</td>
</tr>
</tbody>
</table>
Activity 14.8: Fraction Circles
Prepared Fraction Circle Kits, see activity for directions
45 - 60 minutes

Activity 14.9: Fraction Ring
"Fraction Ring" handout, and prepared Fraction Circle Kits, see activity 14.8 for directions
30 - 60 minutes

Authors
This topic includes excerpts of professional development plans submitted by the following 2004 ABSPD Institute participants.

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Florence Patterson, Central Piedmont Community College
Judy Smith, Martin Community College
Activity 14.1: Scavenger Hunt

This activity is designed as an opening activity to create a non-threatening learning environment as well as encourage group interaction.

Preparation

Make a handout for the “Scavenger Hunt.” Suggestions for items to include are given below. Make adjustments to better “fit” your participants. Make copies of the handout for each participant.

- Has been in current position more than 2 years.
- Has the same number of siblings as you.
- Belongs to a professional organization.
- Lives more than one hour’s drive from work.
- Has to deal with problem students in class.
- Has previously taught in public schools.
- Has more than two pets.
- Has been to Las Vegas.
- Loves to work with adults.
- Uses manipulatives to teach students.
- Favorite subject in school was math.
- Has to deal with students with math anxiety.
- Teaches in a classroom with multi-level students.
- Lives 5 minutes or less from work.
- Has the same hobby as you

Conducting the Activity

Distribute copies of the “Scavenger Hunt” handout. Tell participants they are to mingle with other participants to find people who have the identified characteristics. Once they find a person with that characteristic, ask them to sign their handout beside the characteristic. Ask participants to share interesting information they learned during the activity.
Activity 14.2: Three-In-A-Row

This game allows participants to practice reducing and identifying equivalent fractions while having fun. Two players or two teams work well.

**Preparation**

1. Copy the game board for each team.
2. Each player needs about 10 markers of the same color, with each player on a team having a different color. Make markers by cutting small squares of different colored card stock or use different color buttons, beans, etc.
3. Each team needs one pair of dice.

**Conducting the Activity**

1. Discuss reducing fractions or finding equivalent fractions. Demonstrate and practice reducing fractions before playing the game.
2. Distribute the “Game Board” handouts, dice, and markers. Each player will need ten markers of one color.
3. Players take turns rolling 2 dice and making a fraction. The player covers an equivalent fraction on the game board. If a player rolls doubles, he or she has another turn.
4. The first player to get three in a row in any direction (vertical, horizontal, or diagonal) wins.
# Three–In–A–Row Game Board

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>12</td>
<td>6</td>
<td>12</td>
<td>6</td>
</tr>
<tr>
<td>20</td>
<td>16</td>
<td>9</td>
<td>20</td>
<td>12</td>
</tr>
<tr>
<td>20</td>
<td>12</td>
<td>8</td>
<td>20</td>
<td>10</td>
</tr>
<tr>
<td>30</td>
<td>15</td>
<td>20</td>
<td>24</td>
<td>12</td>
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<tr>
<td>3</td>
<td>3</td>
<td>4</td>
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<td>4</td>
</tr>
<tr>
<td>12</td>
<td>18</td>
<td>24</td>
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<td>12</td>
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<td>7</td>
<td>4</td>
<td>9</td>
<td>5</td>
<td>3</td>
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<td>14</td>
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<td>12</td>
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<td>10</td>
<td>8</td>
<td>15</td>
<td>12</td>
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</tr>
<tr>
<td>25</td>
<td>12</td>
<td>25</td>
<td>18</td>
<td>15</td>
</tr>
</tbody>
</table>
Activity 14.3: Rounding in a Row

This activity offers participants an opportunity to practice calculator, estimating, and rounding skills. It works well for two player teams or for two teams. Two game boards are provided, one for addition and one for multiplication. Additional game boards can be created to cover more basic addition and multiplication or advanced topics such as order of operations, square roots, etc.

Preparation

1. Decide how the game will be played, i.e., individual players or teams. Make copies of the “Rounding in a Row—Addition” and/or “Rounding in a Row—Multiplication” game boards. You will need one game board for each pair of players or teams.

2. Each participant will need a calculator.

Conducting the Activity

1. Give each team a “Rounding in a Row” game board and each participant a calculator.

2. Explain the rules of the game. Rules:
   
   a. This game is played the same way as the classic game, Tic Tac Toe. Marker placement is determined by adding (or multiplying) numbers together, and finding the number closest to that answer on the game board.

   b. Remind participants that the exact answers are not on the game board (answers are rounded to the nearest ten), since one of the skills they are practicing is rounding.

   c. Players take turns.
d. On each turn, the player chooses two numbers from the addend (factor) pool and finds the sum (product) of the two numbers.

e. A calculator may be used.

f. The player finds the number on the board that is closest to the sum (or product) and puts a marker on that number.

g. The first player to have four in a row, horizontally, vertically, or diagonally, wins the game.

3. Prior to beginning the game review the rules for rounding to the nearest ten. Rounding to the nearest ten is as follows:

   a. If the number in the ones’ place is four or less, the rounded number is the nearest multiple of ten that is less than the original number. For example: 573 is rounded to 570.

   b. If the number in the ones’ place is five or more, the rounded number is the nearest multiple of ten that is more than the original number. For example: 576 is rounded to 580.

## Rounding in a Row – Addition

### Addend Pool

<table>
<thead>
<tr>
<th>4</th>
<th>7</th>
<th>11</th>
<th>23</th>
<th>31</th>
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<tbody>
<tr>
<td>42</td>
<td>49</td>
<td>62</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>30</th>
<th>70</th>
<th>40</th>
<th>80</th>
<th>70</th>
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<td>50</td>
<td>110</td>
<td>10</td>
<td>90</td>
<td>40</td>
<td>50</td>
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<td>90</td>
<td>70</td>
<td>130</td>
<td>60</td>
<td>110</td>
<td>70</td>
</tr>
<tr>
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<td>20</td>
<td>100</td>
<td>30</td>
<td>120</td>
<td>50</td>
</tr>
<tr>
<td>70</td>
<td>90</td>
<td>40</td>
<td>100</td>
<td>80</td>
<td>30</td>
</tr>
</tbody>
</table>
## Rounding in a Row – Multiplication

### Factor Pool

<table>
<thead>
<tr>
<th>3</th>
<th>23</th>
<th>31</th>
<th>47</th>
<th>16</th>
</tr>
</thead>
<tbody>
<tr>
<td>18</td>
<td>17</td>
<td>59</td>
<td>13</td>
<td></td>
</tr>
</tbody>
</table>

### Grid

<table>
<thead>
<tr>
<th>140</th>
<th>1460</th>
<th>180</th>
<th>940</th>
<th>390</th>
<th>1830</th>
</tr>
</thead>
<tbody>
<tr>
<td>370</td>
<td>850</td>
<td>1080</td>
<td>210</td>
<td>50</td>
<td>1060</td>
</tr>
<tr>
<td>750</td>
<td>70</td>
<td>270</td>
<td>410</td>
<td>530</td>
<td>220</td>
</tr>
<tr>
<td>710</td>
<td>300</td>
<td>500</td>
<td>90</td>
<td>310</td>
<td>40</td>
</tr>
<tr>
<td>290</td>
<td>560</td>
<td>50</td>
<td>800</td>
<td>1360</td>
<td>770</td>
</tr>
<tr>
<td>50</td>
<td>610</td>
<td>1000</td>
<td>2770</td>
<td>230</td>
<td>400</td>
</tr>
</tbody>
</table>
Activity 14.4: Beach Ball Math

This activity allows participants to practice basic operation and mental math skills. It alleviates the boredom of doing worksheets by playing with a beach ball. This game is especially useful for skills practice with Compensatory Education students. The problems written on the beach ball can be varied to meet the students’ skill levels from counting and number recognition to square roots and exponents.

**Preparation**

1. Prepare beach ball. Cover a large, inflated beach ball with circles by tracing circles using a 3-4 inch diameter pattern (a paper cup works well as a pattern) and a permanent marker.
2. Inside each circle write math problems that focus on the skills you want to reinforce.
3. Prepare a beach ball for each group of 6-8 participants.

**Conducting the Activity**

1. Have participants form a circle. If you have a large group you can form several circles of 6 to 8 participants.
2. Explain the rules of the game:
   a. Toss the ball to a player.
   b. The player who catches the ball must read aloud and answer the problem that is covered by the right thumb.
   c. That player then tosses the ball to another player.
3. Continue to play ball as time allows.
Activity 14.5: Magic Fingers

This is a competency-based basic multiplication hands-on activity and is adaptable for individualized or group instruction. This activity makes the nine table through 10 easier to remember. It is designed for beginning learners.

**Preparation**

1. Practice doing the nine table using the “Magic Fingers” technique.

2. If presenting to a large group, consider the use of an overhead projector to demonstrate using your hands as an opaque.

**Conducting the Activity**

1. First, place your hands in front of you, palms down. Number your fingers (in your mind) from 1 through 10, left to right.

2. Now, nine times any number from 1 through 10 means the finger with that number must be tucked under. For example:

   9 x 3, tuck under the 3rd finger;
3. Counting the fingers on the left of the tucked fingers gives the first digit of the answer. Counting the fingers on the right of the tucked finger gives the last digit of the answer.

4. For example: Refer to the picture above. $9 \times 5$ has four fingers on the left of the tucked finger, this number goes in the tens place of the answer. There are 5 fingers to the left of the tucked finger, the number goes in the ones place of the answer.

\[
9 \times 5 = 4 \text{ in the tens place and } 5 \text{ in the ones place} = 45
\]

5. Look at the picture on the previous page. What is the answer to $9 \times 3$?

6. Practice other “9 times” examples with participants.
Activity 14.6: I have, Who has...

This activity allows participants to practice basic operation skills and mental math skills. Addition and multiplication games are included. However, the game levels can be varied to meet the students’ skill levels from counting and number recognition to basic algebra and geometry skills.

Preparation

1. Decide which game to use, i.e. addition or multiplication.
2. Copy the pages of cards for the corresponding game onto card stock.
3. You may want to laminate the copies to make the cards last longer.
4. Cut the cards apart.
5. This gives you one deck of cards. If you need multiple decks make additional copies.

Conducting the Activity

1. Divide the participants into groups of 6 to 8.
2. One person in each group deals all the cards.
3. Each person spreads the cards, face up, so they can easily see all of their cards.
4. The person who starts the game ends the game. A participant begins the game by reading one card, skipping the first part (I have ...), and beginning with “Who has ...? The same person will end the game with the first part (I have ...) of the card.

5. The person with the answer then reads a card and the game continues until all cards have been read.

6. After a card is read it is turned over. The only card used more than once is the card used to begin the game.

7. Players continue the game until all cards are used.
<table>
<thead>
<tr>
<th>I have 11, who has 4 + 5?</th>
<th>I have 9, who has 6 + 4?</th>
</tr>
</thead>
<tbody>
<tr>
<td>I have 10, who has 4 + 3?</td>
<td>I have 7, who has 6 + 7?</td>
</tr>
<tr>
<td>I have 13, who has 9 + 9?</td>
<td>I have 18, who has 9 + 6?</td>
</tr>
<tr>
<td>I have 15, who has 4 + 4?</td>
<td>I have 8, who has 7 + 12?</td>
</tr>
<tr>
<td>I have 19, who has 6 + 8?</td>
<td>I have 14, who has 0 + 5?</td>
</tr>
<tr>
<td>--------------------------</td>
<td>--------------------------</td>
</tr>
<tr>
<td>I have 5, who has 2 + 4?</td>
<td>I have 6, who has 8 + 9?</td>
</tr>
<tr>
<td>I have 17, who has 8 + 8?</td>
<td>I have 16, who has 7 + 5?</td>
</tr>
<tr>
<td>I have 12, who has 9 + 11?</td>
<td>I have 20, who has 15 + 13?</td>
</tr>
<tr>
<td>I have 28, who has 3 + 1?</td>
<td>I have 4, who has 18 + 5?</td>
</tr>
<tr>
<td>--------------------------</td>
<td>--------------------------</td>
</tr>
<tr>
<td>I have 23, who has 13 + 8?</td>
<td>I have 21, who has 0 + 0?</td>
</tr>
<tr>
<td>I have 0, who has 1 + 2?</td>
<td>I have 3, who has 20 + 9?</td>
</tr>
<tr>
<td>I have 29, who has 1 + 1?</td>
<td>I have 2, who has 6 + 5?</td>
</tr>
<tr>
<td>I have 30, who has 3 x 3?</td>
<td>I have 16, who has 6 x 4?</td>
</tr>
<tr>
<td>--------------------------</td>
<td>--------------------------</td>
</tr>
<tr>
<td>I have 9, who has 4 x 3?</td>
<td>I have 24, who has 7 x 3?</td>
</tr>
<tr>
<td>I have 12, who has 9 x 9?</td>
<td>I have 21, who has 9 x 6?</td>
</tr>
<tr>
<td>I have 81, who has 4 x 4?</td>
<td>I have 54, who has 7 x 2?</td>
</tr>
<tr>
<td>I have 14, who has 6 x 8?</td>
<td>I have 48, who has 5 x 5?</td>
</tr>
<tr>
<td>--------------------------</td>
<td>--------------------------</td>
</tr>
<tr>
<td>I have 25, who has 2 x 5?</td>
<td>I have 10, who has 5 x 9?</td>
</tr>
<tr>
<td>I have 45, who has 8 x 8?</td>
<td>I have 64, who has 7 x 6?</td>
</tr>
<tr>
<td>I have 42, who has 9 x 11?</td>
<td>I have 99, who has 5 x 3?</td>
</tr>
<tr>
<td>I have 15, who has 7 x 7?</td>
<td>I have 49, who has 8 x 5?</td>
</tr>
<tr>
<td>--------------------------</td>
<td>--------------------------</td>
</tr>
<tr>
<td>I have 40, who has 9 x 8?</td>
<td>I have 72, who has 4 x 9?</td>
</tr>
<tr>
<td>I have 36, who has 9 x 2?</td>
<td>I have 18, who has 7 x 4?</td>
</tr>
<tr>
<td>I have 28, who has 3 x 2?</td>
<td>I have 6, who has 7 x 12?</td>
</tr>
<tr>
<td>I have 84, who has 4 x 8?</td>
<td>I have 32, who has 10 x 5?</td>
</tr>
<tr>
<td>--------------------------</td>
<td>--------------------------</td>
</tr>
<tr>
<td>I have 50, who has 8 x 12?</td>
<td>I have 96, who has 3 x 9?</td>
</tr>
<tr>
<td>I have 27, who has 4 x 2?</td>
<td>I have 8, who has 8 x 7?</td>
</tr>
<tr>
<td>I have 56, who has 7 x 5?</td>
<td>I have 35, who has 6 x 5?</td>
</tr>
</tbody>
</table>
Activity 14.7: Playing Cards to Learn Math

Most everyone likes playing cards. The games included here allow participants to have fun while sharpening their math skills. These games create learning or reinforcement of number sense, problem solving, and thinking skills. Through working together as a team students practice communication skills as well as mental math, pencil and paper and/or calculator skills. Additionally, students have to follow directions and rules. These games are especially helpful for students who have math anxiety, learning difficulties, or disabilities. All games can easily be adjusted for difficulty level.

After students learn the rules, card games let students “take a break” from long classes. Choose a game that reinforces the math skills currently being learned or use the game as a review.

Preparation

1. You will need decks of cards (one for every 3 to 5 participants) with the face cards (kings, queens, and jacks) removed.

2. Calculators are optional, but card games are a good way to practice calculator skills and in some cases the use of a calculator may make the game move faster.

3. Choose the card game you want to play. Make adjustments to the rules as necessary. For all games aces count as one.
Conducting the Activity

1. When participants enter class have decks of cards on some of the desks. Ask participants, “Have you considered playing cards to learn and reinforce math skills?” Advise the participants that today they will play cards. This will get the participants’ attention. Then tell them, “There is one catch – you must play by the game rules I give you.”

2. Have participants form small groups. No more than five participants should play with a single deck.

3. Explain and demonstrate how the game will be played. It will be helpful to list the rules on the board. Remember, for all games let the aces count as ones. Give participants a chance to ask questions to clarify the rules of the game. Then – Let the games begin.

4. After the game reflect on what happened while playing – worked together as a team, had fun, learned or reinforced math skills, practiced communication skills, had to think, practiced mental math, pencil and paper and/or calculator skills, had to follow directions and rules, etc.

5. Ask participants to share what math skills they learned, practiced, and/or reinforced. List on the board.

6. Optional: As a class or in small groups let participants make up and write rules for a different card game that could be used to teach or reinforce math skills.
Game #1: What Difference Does it Make?

Remove the face cards from the deck and deal the cards face down, one to each player, and one in the middle of the playing table until all the cards are dealt.

Each player turns up their top card. The top card is turned up from the deck. Players then state and record on paper what they need to add or subtract from their cards to make it equal to the deck's card.

For example, suppose the cards show the following:

- This player has a 10, therefore the player states, "subtract 7" and records a "-7" on the score paper.
- This player has a 2, therefore the player states, "add 1" and records a +1 on the score paper.

Keep playing rounds until the players have used up all their cards. Each player adds the differences. The player with the score closest to zero wins. Or you can announce at the beginning of the game that the player with the highest (or lowest) score wins.
Alternate Ways to Play

1. Let players record the sum of two cards and let the winner be the one with the highest or lowest total.

   This player has a 10, therefore the player states \(10 + 3 = 13\) and records 13 on the score paper.

   This player has a 2, therefore the player states \(2 + 3 = 5\) and records 5 on the score paper.

2. Let players record the product of two cards and let the winner be the one with the highest total product. In this case player 1 would record 30 (10 \(\times\) 3) and player 2 would record 6 (2 \(\times\) 3).

3. Let players make a fraction out of the two cards, with the player’s card always being the numerator. In this case player 1 records \(10/3\) or 3 \(\frac{1}{3}\) and player 2 records 2/3. Add strategy to the game by letting the players decide which card to use as the numerator and denominator. Each player records the fraction they made as their score and totals the fractions to see who has the largest or smallest total. Before the game begins decide if the winner will be the player with the largest (or smallest) total.
Game #2: Mark Off!

Remove the face cards from the deck. Each player writes the numbers 1 through 20 on a piece of paper. The object of the game is to be the first player to "Mark Off" all of the numbers on the list.

For each round, two cards are dealt to each player. Players find the total value of the two cards. The player can choose to mark off the sum of the two cards or to mark off two or three numbers that would give them the same total value. For example, suppose a player has the cards below:

These two cards gives the player a sum of 16. The player can choose to mark off any one of the following combinations:

<table>
<thead>
<tr>
<th>16</th>
<th>6 and 10</th>
</tr>
</thead>
<tbody>
<tr>
<td>9 and 7</td>
<td>2, 4, and 10</td>
</tr>
<tr>
<td>2, 6, and 8</td>
<td>15 and 1</td>
</tr>
</tbody>
</table>

or any other combination that gives the total value of 16.

As the rounds progress, it becomes harder to mark off the exact total, which is what the rules specify. When a player cannot mark off a combination of numbers that equals the exact total, the player does not get to mark off anything and must wait until they receive another two cards. In this game, strategy counts. For a shorter game, set a time limit and let the player who has marked off the most numbers win.
Game #3: Blackjack Times Ten

The object of this game is to get as close as possible to 210 (Blackjack times 10), without going over. After removing the face cards, each player draws (or is dealt) six cards. The player decides whether to use the cards in the ones place or tens place so the sum is as close to 210 without going over. Each player must use all six of the cards. Give the players a set amount of time to arrange their cards. The player who gets closest to 210 without going over is the winner.

For example, if a player draws (or is dealt) the following:

They may choose to split the cards as follows:

<table>
<thead>
<tr>
<th>Tens Place</th>
<th>Ones Place</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nine of spades = 90</td>
<td>Ace of diamonds = 1</td>
</tr>
<tr>
<td>Two of diamonds = 20</td>
<td>Ten of clubs = 10</td>
</tr>
<tr>
<td>Eight of spades = 80</td>
<td>Three of clubs = 3</td>
</tr>
</tbody>
</table>

Total score $\rightarrow 90 + 20 + 80 + 1 + 10 + 3 = 204$

Alternate Ways to Play

Instead of trying to reach 210 without going over, try to reach 100 or 500 without going over. A hundreds place could be added, then the players can try to reach 1000 without going over. The number of cards dealt can be increased or decreased to make the game harder or easier.
Game #4: Equations, Equations, Equations...

After removing the face cards, deal each player four cards. Using the four cards and any combination of addition, subtraction, multiplication, division, and grouping symbols, make as many equations as possible that have integer answers. You get 1 point for each equation with a different answer. Set a time limit; 3 to 5 minutes works well, but participants can easily spend longer if time permits.

For example, suppose a player draws the following cards:

The player could start with the following equations:

\[
\begin{align*}
3 + 1 + 10 + 5 &= 19 \\
3 - 1 - 10 + 5 &= -3 \\
3 \times 1 + 10 + 5 &= 18 \\
3 + 1 \times 10 + 5 &= 18 \quad \text{– same answer doesn’t count} \\
3 \times (1 + 10 + 5) &= 48 \\
(10 + 5) / 3 + 1 &= 6
\end{align*}
\]

and so on. There are many other equations that could be made with these four cards.

Alternate Ways to Play

The game can be played where every different equation counts, even if it has the same answer. Decimal and fractions can be allowed as answers; thus making it easier to make more equations. Have participants think of other ways to vary this game.
Game #5: Make it a Million or More!

Each player marks on a piece of paper the place values to a million. Space the place values so that a card can fit under each place.

Remove the face cards from the deck. Each player alternates drawing one card at a time and puts it in a place, trying to make the largest 7-digit number possible. Once placed, the card cannot be moved. One round goes until each player has 8 cards. At that point, each player gets to choose one card to replace with the eighth card to make the largest 7-digit number possible, or they may choose to "throw out" the eighth card.

Here is how a hand might look.

The above hand would result in the number $10,983,621$.

Try your luck. Can you make a larger number by moving around the cards? Be careful about reading the number, especially if a ten-card is placed other than in the millions.

Alternate ways to play

This game can be played with fewer or more place values to vary difficulty. Consider adding a decimal and tenths, hundredths, etc. The number of cards dealt can be varied based on the number of place values. Ask participants to think of other ways to vary this game.
Game #6: Making the Largest Fraction

Remove the face cards from the deck. Deal the remaining cards face down to the players. Players turn over the top two cards of their hand and make the largest fraction possible using one of the cards as the numerator and the other as the denominator. The players compare fractions to see who has the largest. The player with the largest fraction gets all the cards to add to the bottom of his/her hand. When a player has less than two cards, he/she is out of the game. The winner is the player who gets all the cards.

Below are three fractions that can be made.

\[
\begin{align*}
\text{\( \frac{9}{2} \)} \quad \text{\( \frac{8}{1} \)} \quad \text{\( \frac{10}{3} \)}
\end{align*}
\]

The largest fraction above is the one in the middle, so the person having this fraction adds all six of the above cards to the bottom of his/her hand.

Alternate Ways to Play

Players turn over three cards and make a mixed number. Can you think of other variations?
Activity 14.8: Fraction Circles

Students need to understand the meaning of fractions and have a clear concept of what a fraction of an object looks like. The focus of this activity is dealing with fractions as part of a whole. Students learn that each fraction has many alternate names, i.e., \( \frac{1}{4} = \frac{2}{8} = \frac{3}{12} \) etc., and learn how to change between improper fractions and mixed numbers. Fraction circles are used to ensure that students have a thorough, concrete understanding of the processes. Students respond to this activity with statements such as, “I see!” or “Now it makes sense.” The effort of making the “Fraction Circle Kits” is definitely worthwhile.

Preparation

1. Copy the fraction circles at the end of the activity onto colored card stock. Use a different color for each fraction. One copy of each page yields 3 sets of fraction circles.

2. Cut out the fraction circles or let participants cut them out. This will make enough fraction circles for one small class (up to 8 participants). Make additional sets as needed.

Conducting the Activity

1. Mix up the fraction pieces.

2. Allow participants time to examine the kit. Ask participants to make as many “single colored circles” as they can.

3. Ask participants to “name the pieces.” Hold up pieces of each color and ask, “What is this called?” and “How is this written?”

4. Record answers on the board. For example, for the one-fourth piece (if it is blue), record

   blue piece  a fourth  \( \frac{1}{4} \)

5. Ask participants why the piece is called a fourth and why it is written as one over four. Stress the meaning, i.e, one of four
parts make up a whole circle or it is one piece of the whole circle which has been divided into four equal pieces.

6. Repeat the procedure until all pieces have been named.

7. **Numerator** other than one. Place two pieces of the same fractional part together and ask, “What is this called?” and “How is it written?” Record answers.

8. Repeat the procedure with other colors until everyone can name the fractions and tell why the name is appropriate.

   2 blue pieces          2/4
   3 blue pieces          3/4
   4 blue pieces          4/4  one whole

9. **Relative size of fractions.** Hold up two pieces of different colors. Ask, “Which piece is larger?”, “How do we represent greater than and less than?” “How can we represent such statements as ‘the yellow piece is larger than the brown piece’ in symbols?” For example, 1/2 > 1/6.

10. The relative size of the piece can be determined by placing one piece on top of another piece.

11. Encourage participants to generalize a rule such as, “The larger the number on the bottom the smaller the actual size of the piece.” The term denominator could be introduced this way.

12. **Equivalent fractions.** Hold up the 1/2 piece. Ask, “How many other ways could we make a piece this size using other colors?” Record answers on the board. Hold up other pieces and ask the same question.

13. **Improper fractions and mixed numbers.** These concepts can be introduced using the fraction circles. Use examples such as, “I’m having people to lunch and serving small cakes for desert. I know from experience that people will only eat a half. If I am having 6 people how many cakes would I need? 7 people? 9 people?” Try other examples such as serving pie that would serve six people or serving pizza that would serve four. Be sure to record answers on the board so participants can see the difference between improper fractions and mixed numbers.
Activity 14.9: Fraction Ring

Students need to understand the relationship between fractions, decimals, and percents. The focus of this activity is to help students see the relationship between common fractions, decimals, and percents. Students will also learn that each fraction has a decimal and percent equivalent. The fraction ring and fraction circles (from previous activity) are used to ensure that students have a thorough, concrete understanding of the processes.

Preparation

1. Copy the fraction circles at the end of the previous activity onto colored card stock. Use a different color for each fraction. One copy of each page yields 3 sets of fraction circles.
2. Cut out the fraction circles and sort to make three sets.
3. Make additional copies of the “whole” fraction, so that each participant can have a whole circle, for Part II of the activity.
4. Make copies of the “Fraction Ring” handout.

Conducting the Activity, Part I

1. Give each participant a copy of the “Fraction Ring” handout.
2. Explain the “fraction ring.” It represents one whole, the scale around the edge divides it into 100 equal parts so we have 100% of a circle. Review how to change decimals to percents.
3. Allow participants to choose a partner.
4. Give each pair of participants several fraction circles.
5. Ask participants to put together the fraction circles to make a whole of the same color. Ask participants to label, in fraction form (1/4, 1/5, 1/6, etc.) one piece from each of the circles.

6. Explain that if one of the fractions pieces is placed on the fraction ring beginning at zero, one can easily determine the decimal equivalent and find the percent equivalent by changing the decimal to a percent.

7. Demonstrate by placing one fraction piece (1/4) on the circle. Ask, “What decimal part of the circle is this piece?” (.25) Ask, “What would equal that percent?” (25%)

8. Ask participants to repeat this procedure (step 7) with each of the different fraction pieces and to make a chart by tracing the fraction piece and labeling the fraction, decimal, and percent.

**Conducting the Activity, Part II**

9. Give each participant a whole circle.

10. Demonstrate how to make a pie chart using the fraction ring.

11. Discuss budgets. What items need to be included in a budget? Is everyone going to have the same items in a budget? A budget cannot exceed what part of a person’s income?

12. Demonstrate how to make a pie chart for a budget by deciding on a random income. List the budget items and what percent a person might spend in that area. On the whole circle pencil in that percentage. Is the person going to have enough income to cover all the expenses? Convert the percentages to actual dollar amounts. Are there budget items that can be changed? Which budget items are fixed and which are flexible?

13. Participants make a pie chart for their budget.

14. Discussion categories participants chose to include in their budgets.
Fraction Ring
Fun with Algebra, Geometry, and Graphing

Dianne B. Barber
2004 ABSPD Institute Participants

Americans need to think for a living, more than ever they need to think mathematically.

Everybody Counts
Overview

Many students come into our Adult Basic Skills programs fearing math, especially algebra and geometry. Students believe algebra is impossible to learn and that geometry is almost as bad. Many students think graphs are intimidating. These beliefs stifle students in their quest to acquire skills needed to open doors in the workplace and to higher education. This professional development plan offers instructional games and activities that can be used to promote mathematical confidence while introducing students to basic algebra, geometry, and graphing concepts.

Goal

The goal of this plan is to provide professional development using research-based methods, strategies, and techniques to give instructors new ways to demonstrate and review basic algebra, geometry and graphing concepts in a fun, non-threatening way.

Objectives

Participants will

- learn methods and strategies for teaching basic algebra and geometry skills;
- engage in hands-on activities that enrich algebra, geometry, graphing, and thinking skills;
- identify elements of graphs and create graphs; and
- evaluate math activities found on the Internet.
Summary of Activities

Many games and activities are included in this plan. Unless a series of professional development workshops are planned, trainers need to choose from among the activities listed. As well as being the main focus of a workshop, these activities are good for opening, closing, or after-break activities for math workshops.

Activities 2-7 are written for the classroom thus providing detailed instructions for conducting them with students. As the trainer, adjust as necessary for your participants’ backgrounds and knowledge of the mathematical concepts.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Materials</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Activity 15.1:</strong> Ticket to Algebra</td>
<td>“A Ticket to Algebra, Please” handout and prepared tickets as described in the activity</td>
<td>30 - 45 minutes</td>
</tr>
<tr>
<td><strong>Activity 15.2:</strong> I have, Who has … Exponents and Square Roots</td>
<td>Prepared deck(s) of cards as described in the activity</td>
<td>10 - 20 minutes</td>
</tr>
<tr>
<td><strong>Activity 15.3:</strong> Concentrate on Algebra</td>
<td>Prepared deck(s) of cards as described in the activity</td>
<td>15 - 30 minutes</td>
</tr>
<tr>
<td><strong>Activity 15.4:</strong> Geometric Art</td>
<td>Digital camera, printer to print pictures, poster board, glue</td>
<td>60 - 90 minutes</td>
</tr>
<tr>
<td><strong>Activity 15.5:</strong> Concentrating on Formulas</td>
<td>Prepared deck(s) of cards as described in the activity</td>
<td>15 - 30 minutes</td>
</tr>
</tbody>
</table>
Activity 15.6: Toy Design
Collection of toys
60 - 90 minutes

Activity 15.7: Graphed Comparisons
Sample graphs (good and bad) from newspapers and magazines, access to the Internet or prepared data handouts, graph paper and markers or colored pencils
60 - 90 minutes

Activity 15.8: Techin’ Up Your Teaching
Access to the Internet and “Math Websites” and “Math Web Quests” handouts
60 - 90 minutes

Authors

This topic includes excerpts of professional development plans submitted by the following 2004 ABSPD Institute participants.

Ruth Duncan, Vance-Granville Community College
Lynn LeFever, Caldwell Community College & Technical Institute
Elizabeth Hembree, Haywood Community College
Kim Hinton, Caldwell Community College & Technical Institute
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Billie Rich, Haywood Community College
Anne Seitz, Appalachian State University
Karen Towery, Appalachian State University
Activity 15.1: Ticket to Algebra

This activity may be used to introduce participants to variables and basic algebraic equations. Using tickets to sporting events, concerts, and movies grabs the participants’ interest.

Preparation

1. Make copies of the “A Ticket to Algebra, Please” handout for each participant.

2. Make copies of the page of tickets included or you may create your own tickets. You will need several of each ticket. Be sure to make enough copies so that each participant has a ticket. You also want to be sure that at least three participants have the same ticket.

3. Cut apart the tickets so that you have individual tickets to distribute to participants.

Conducting the Activity

1. Give each participant a ticket. Participants may trade if they wish to attend a different event. When each person has the ticket they desire, have them group according to the destination.

2. Distribute the “A Ticket to Algebra, Please” handout.

3. Go through the mini-lesson using a similar presentation to this:
   a. Using these tickets, we are going to introduce the concept of unknowns.

   b. Explain that to represent the ticket in math today, we are going to use the letter T. This will save time as opposed writing out the word each time.

   c. Count the number of tickets you have for your event. If you have 5 tickets, on your handout write 5T on the line beside your event. If you have 2 tickets, write 2T, etc.
d. Now look at the cost of one of your tickets. If one of your tickets costs $2.00, then 5T is worth $10.00. Add the cost of your tickets together to see what they are worth. Your tickets are different prices according to your event. Since the value of the T varies, we can call it a variable. The value of 5T varies according to the ticket you have.

e. Write out the equation: 5T = $10

f. If one ticket is worth $2, then T = $2

4. As a group, using the overhead or board, complete the handout with “ticket equations” for the other events.

5. Discuss how the unknown could change based on the information known, i.e. if 5 people bought tickets at $12 each, what was the total cost of the tickets. In this case, if we use “C” for cost, then C = 5 x 12.

6. Ask participants to think about other ways they use variables (unknowns) in their daily life.

7. Explain that this is only one way to introduce students to variables. Ask participants to share how they introduce the use of variables to their students.
<table>
<thead>
<tr>
<th>Event</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>UNC BASKETBALL</td>
<td>$20.00</td>
</tr>
<tr>
<td>NASCAR RACE</td>
<td>$40.00</td>
</tr>
<tr>
<td>HIGH SCHOOL FOOTBALL</td>
<td>$3.00</td>
</tr>
<tr>
<td>COUNTRY MUSIC CONCERT</td>
<td>$28.00</td>
</tr>
<tr>
<td>NEW YORK BALLET</td>
<td>$64.00</td>
</tr>
<tr>
<td>NC MUSEUM OF ART</td>
<td>$8.00</td>
</tr>
<tr>
<td>NC ZOO</td>
<td>$12.00</td>
</tr>
<tr>
<td>NC HOME &amp; GARDEN SHOW</td>
<td>$6.00</td>
</tr>
</tbody>
</table>
A Ticket to Algebra, Please

UNC BASKETBALL

NASCAR RACE

HIGH SCHOOL FOOTBALL

COUNTRY MUSIC CONCERT

NEW YORK BALLET

NC MUSEUM OF ART

NC ZOO

NC HOME & GARDEN SHOW
Activity 15.2: I have, Who has...
Exponents and Square Roots

This activity allows students to practice exponential and square root skills while playing with cards. It is especially good to give students a “break” during long classes.

Preparation

1. Copy the pages of cards onto card stock.
2. You may want to laminate the copies to make the cards sturdier.
3. Cut the cards apart.
4. This gives you one deck of cards. If you need multiple decks make additional copies.

Conducting the Activity

1. Divide the participants into groups of 6 to 8.
2. One person in each group deals all the cards.
3. Each person spreads the cards face up, so they can easily see them.
4. The person who starts the game ends the game. Participant begins the game by reading one, skipping the first part (I have ...), and beginning with “Who has ...? The same person will end the game with the first part (I have ...) of the card.
5. The person with the answer then reads a card and the game continues until all cards have been read.
6. After a card is read it is turned over. The only card used more than once is the card used to begin the game.
7. Players continue the game until all cards are used.
I have, Who has …ROOTS & EXPONENTS Cards-Copy and cut apart.

<table>
<thead>
<tr>
<th>I have 30, who has $3^2$?</th>
<th>I have 8, who has $\sqrt{36}$?</th>
</tr>
</thead>
<tbody>
<tr>
<td>I have 7, who has $3^3$?</td>
<td>I have 9, who has $\sqrt{144}$?</td>
</tr>
<tr>
<td>I have 16, who has $\sqrt{121}$?</td>
<td>I have 64, who has $7^2$?</td>
</tr>
<tr>
<td>I have 125, who has $\sqrt{4}$?</td>
<td>I have 20, who has $2^5$?</td>
</tr>
<tr>
<td>I have 2, who has $\sqrt{400}$?</td>
<td>I have 121, who has $5^3$?</td>
</tr>
<tr>
<td>---------------------------------</td>
<td>-----------------------------</td>
</tr>
<tr>
<td>I have 6, who has $\sqrt{16}$?</td>
<td>I have 12, who has $9^2$?</td>
</tr>
<tr>
<td>I have 27, who has $\sqrt{64}$?</td>
<td>I have 36, who has $1^3$?</td>
</tr>
<tr>
<td>I have 5, who has $5^2$?</td>
<td>I have 1, who has $0^4$?</td>
</tr>
<tr>
<td>I have 32, who has $\sqrt{900}$?</td>
<td>I have 4, who has $11^2$?</td>
</tr>
<tr>
<td>---------------------------------</td>
<td>---------------------------------</td>
</tr>
<tr>
<td>I have 11, who has $\sqrt{25}$?</td>
<td>I have 81, who has $4^2$?</td>
</tr>
<tr>
<td>I have 25, who has $\sqrt{100}$?</td>
<td>I have 49, who has $6^2$?</td>
</tr>
<tr>
<td>I have 0, who has $\sqrt{49}$?</td>
<td>I have 10, who has $8^2$?</td>
</tr>
</tbody>
</table>
Activity 15.3: Concentrate on Algebra

This game is designed to help students learn, recognize, and review basic algebra terms. Similar card games for all levels of math (basic math, geometry, statistics, etc.) can be made using the terms and definitions found in the Mathematical Terms chapter or additional vocabulary words students need to know.

Preparation

1. Copy the pages of cards onto card stock.
2. You may want to laminate the copies to make the cards sturdier.
3. Cut the cards apart.
4. This gives you one deck of cards. Make additional copies so that each group of 3-4 players will have a deck.

Conducting the Activity, Part I

1. Players form groups of 4.
2. Give each group a set of cards.
3. Explain that the cards contain words and definitions that have been used in their study of algebra. (You may choose to add or remove terms and definitions from the deck of cards).
4. Allow time for all players to review the cards. Players match terms and definitions with the cards face up. Be sure players can match the cards face up before proceeding.

Conducting the Activity, Part 2

5. A player shuffles the cards and then places the cards face down in rows on the table.
6. Each player takes a turn trying to match two cards, i.e., a term with the correct definition. When a match occurs the player keeps the two cards.
7. The game continues until all the cards have been matched.
8. A player may challenge another player if he/she thinks the match is not correct and request the facilitator check the match.
9. The winner is the one who has the most matches.
<table>
<thead>
<tr>
<th><strong>absolute value</strong></th>
<th>the distance a number is from 0 on the number line</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>algebraic expression</strong></td>
<td>a mathematical statement involving variables and/or numbers written in words or symbols</td>
</tr>
<tr>
<td><strong>associative property</strong></td>
<td>grouping does not matter in addition or multiplication</td>
</tr>
<tr>
<td><strong>binominal</strong></td>
<td>an algebraic expression containing two terms, e.g., 2a + 3b</td>
</tr>
<tr>
<td><strong>coefficient</strong></td>
<td>the number in front of a variable, e.g., in the term “4a” the coefficient is 4</td>
</tr>
<tr>
<td>-----------------</td>
<td>-------------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>commutative property</strong></td>
<td>order does not matter in addition or multiplication, e.g., $2 + 3 = 3 + 2$ and $2 \times 3 = 3 \times 2$.</td>
</tr>
<tr>
<td><strong>denominator</strong></td>
<td>the bottom number of a fraction; tells the number of parts in a whole</td>
</tr>
</tbody>
</table>
| **distributive property** | }
<table>
<thead>
<tr>
<th><strong>equation</strong></th>
<th>two (or more) things that are equal</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>evaluate</strong></td>
<td>to work out the value of an expression when numbers have been substituted for variables</td>
</tr>
<tr>
<td><strong>exponent</strong></td>
<td>the number of times a number is multiplied by itself</td>
</tr>
<tr>
<td><strong>expression</strong></td>
<td>a mathematical statement involving variables and/or numbers written in words or symbols</td>
</tr>
<tr>
<td><strong>factor</strong></td>
<td>a number that divides evenly into another number, e.g., $24 = 3 \times 8$, so 3 and 8 are factors</td>
</tr>
<tr>
<td>---------------------</td>
<td>-------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>integer</strong></td>
<td>any positive or negative whole numbers including zero</td>
</tr>
<tr>
<td></td>
<td><img src="image" alt="Integer Numbers" /></td>
</tr>
<tr>
<td><strong>inverse operations</strong></td>
<td>operations that, when combined, leave the entity on which they operate unchanged, e.g., $(3 + 4 - 4 = 3)$ and $(3 \times 4 \div 4 = 3)$.</td>
</tr>
<tr>
<td><strong>like terms</strong></td>
<td>terms that have the exact same variable(s) raised to the exact same power(s)</td>
</tr>
<tr>
<td><strong>monomial</strong></td>
<td>an expression with one term</td>
</tr>
<tr>
<td>--------------</td>
<td>-----------------------------</td>
</tr>
<tr>
<td><strong>negative number</strong></td>
<td>a number less than 0.</td>
</tr>
<tr>
<td><strong>numerator</strong></td>
<td>the top number of a fraction; it tells how many parts of the whole were used</td>
</tr>
<tr>
<td><strong>order of operations</strong></td>
<td>rules for finding the value of mathematical expressions</td>
</tr>
<tr>
<td><strong>prime number</strong></td>
<td>A prime number has exactly two factors, itself and 1.</td>
</tr>
<tr>
<td>-----------------</td>
<td>-----------------------------------------------------</td>
</tr>
<tr>
<td><strong>proportion</strong></td>
<td>An equation made up of two equal ratios</td>
</tr>
<tr>
<td><strong>reciprocal</strong></td>
<td>The reversal of a fraction, to turn upside down, e.g., the reciprocal of $\frac{2}{3}$ is $\frac{3}{2}$</td>
</tr>
<tr>
<td><strong>simplify</strong></td>
<td>Work out to give the shortest possible answer</td>
</tr>
<tr>
<td><strong>substitute</strong></td>
<td>to assign a value to a variable</td>
</tr>
<tr>
<td>----------------</td>
<td>---------------------------------</td>
</tr>
<tr>
<td><strong>term</strong></td>
<td>one of the parts of an expression, e.g., $3a - 2$ has two terms: $3a$ and $-2$</td>
</tr>
<tr>
<td><strong>trinomial</strong></td>
<td>an algebraic expression containing three terms</td>
</tr>
<tr>
<td><strong>variable</strong></td>
<td>a letter or symbol used to represent an unknown number</td>
</tr>
</tbody>
</table>
Activity 15.4: Geometric Art

This activity focuses on looking at the world around us and recognizing how geometry is used. This activity can be used with any level Adult Basic Skills student. Since this activity requires taking and printing pictures, it may be best to plan for participants to take pictures early and finish the activity later that day or even another day.

Preparation

1. Each group of participants (4-5 per group) will need use of a digital camera.
2. Have technical support available to download and print the pictures or access to computers and printers so that participants can print their own.
3. Poster board and glue for each group.

Conducting the Activity

1. Participants divide into groups of 4-5. At least one person in each group should know how to operate a digital camera.
2. Instruct each group to spend 10-15 minutes taking pictures of a variety of items outside or inside that relate to geometry.
3. Advise groups that they may take as many pictures as time allows, however they will only be allowed to print up to ten.
4. Explain that they will be using their pictures to create a “Geometric Art Collage.” Encourage the groups to be as creative as possible.
5. As participants return with their pictures, participants print their own pictures.
6. After printing their pictures, participants arrange the photos in a collage on poster board. Give each group poster board and glue.

7. Groups present their collage to the class, explaining why they chose the pictures used in their “Geometric Art Collage” to represent geometry.

8. Call attention to the variety of pictures. Discuss why things are made in a particular shape. Discuss other ways geometry is used around us on a daily basis.
Activity 15.6: Concentrating on Formulas

Formulas are extremely useful tools for many areas of problem solving. Often students have difficulty recognizing which formula is needed to solve a particular problem. This activity is designed to help students practice identifying the formula needed to complete a certain task.

Preparation

1. Copy the pages of cards onto card stock.
2. You may want to laminate the copies to make the cards sturdier.
3. Cut the cards apart.
4. This gives you one deck of cards. Make additional copies so that each group of 3-4 players will have a deck.

Conducting the Activity

1. Players form groups of 3-4.
2. Give each group a set of cards.
3. Explain that the cards contain a formula or the description of a task that would require the use of the formula. (You may choose to add or remove formulas and tasks from the deck of cards).
4. Let participants practice with matching the pairs of cards with the cards face up. Once participants have mastered matching the cards face up, let them play the game outlined in steps 5-9.
5. One player from each group shuffles the cards and then places the cards face down in rows on the table.
6. Each player takes a turn trying to match two cards correctly. When a match occurs that player keeps the two cards.
7. The game continues until all the cards have been matched.
8. A player may challenge another player if he/she thinks the match is not correct and request the facilitator check the match.
9. The winner is the one who has the most matches.
### Formula Cards – Copy and cut apart.

<table>
<thead>
<tr>
<th>Formula</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>( A = s^2 )</td>
<td>to find how much carpet is needed for a room that has the same length and width</td>
</tr>
<tr>
<td>( A = lw )</td>
<td>to find the amount of carpet needed to carpet a room that is twice as long as it is wide</td>
</tr>
<tr>
<td>( A = bh )</td>
<td>to find the area of a parallelogram</td>
</tr>
<tr>
<td>( A = \frac{1}{2}bh )</td>
<td>to find how much paint it would take to paint the floor of a triangular patio</td>
</tr>
</tbody>
</table>
### Formula Cards

<table>
<thead>
<tr>
<th>Formula</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>[ A = \pi r^2 ]</td>
<td>To find how much paint to buy to paint a big circle on the wall. ( A = ) area and ( r = ) radius.</td>
</tr>
<tr>
<td>[ P = 4s ]</td>
<td>To find how much ribbon to buy to go around the edge of a square box. ( P = ) perimeter and ( s = ) side.</td>
</tr>
<tr>
<td>[ P = 2l + 2w ]</td>
<td>To find how much baseboard to buy to go around a room that is twice as long as it is wide. ( P = ) perimeter, ( l = ) length, and ( w = ) width.</td>
</tr>
<tr>
<td>[ P = s_1 + s_2 + s_3 ]</td>
<td>To find how much fencing it would take to go around a triangular flower garden. ( P = ) perimeter, and ( s = ) side.</td>
</tr>
</tbody>
</table>
**Formula Cards—Copy and cut apart.**

\[ C = \sqrt{\pi d} \]

where \( C = \) circumference and \( d = \) diameter

- to find how far it would be to walk around a round lake

\[ V = e^3 \]

where \( V = \) volume and \( e = \) edge

- to find how much soil it would take to fill a square flower pot

\[ V = lwh \]

where \( V = \) volume, \( l = \) length, \( w = \) width, and \( h = \) height

- to find how much water it would take to fill a rectangular swimming pool

\[ V = \frac{1}{3} b^2 h \]

where \( V = \) volume, \( b = \) base, and \( h = \) height

- to find the amount a container shaped like a square pyramid would hold
<table>
<thead>
<tr>
<th>Formula</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V = \sqrt{\pi r^2 h}$</td>
<td>to find the amount a cylinder shaped container would hold</td>
</tr>
<tr>
<td>$V = \frac{1}{3} \pi r^2 h$</td>
<td>to find the amount a cone shaped container would hold</td>
</tr>
<tr>
<td>$d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$</td>
<td>to find the distance between two points on a line</td>
</tr>
<tr>
<td>$m = \frac{y_2 - y_1}{x_2 - x_1}$</td>
<td>to find the steepness of a line</td>
</tr>
</tbody>
</table>

where $V$ = volume, $r$ = radius, and $h$ = height.

distance and $(x_1, y_1)$ and $(x_2, y_2)$ are two points in a plane.

where $m$ = slope and $(x_1, y_1)$ and $(x_2, y_2)$ are two points on a line.
\[ a^2 + b^2 = c^2 \]
where \( a \) and \( b \) are legs and \( c \) the hypotenuse of a right triangle

to find the length of a beam across the front of a garage if the angle at the roof is 90 degrees

\[ I = p r t \]
where \( I = \) interest, \( p = \) principal, \( r = \) rate, and \( t = \) time

to find the interest from a savings account

\[ d = r t \]
where \( d = \) distance, \( r = \) rate, and \( t = \) time

to find the distance for a trip

\[ C = n r \]
where \( C = \) total cost, \( n = \) number of units, and \( r = \) cost per unit

to find the cost of vegetables sold by the pound
Activity 15.6: Toy Design

Geometric shapes are used in the design and manufacture of many products. This activity allows participants to study the different shapes used in designing toys. It is great for a multi-level classroom as even beginning students can participate.

Preparation

1. Have toys available so that each pair of participants has a different toy. If you have a class where most participants have children you might ask if they would be willing to bring a toy to share for this activity. You may also be able to purchase inexpensive toys at yard sales and thrift stores. If you cannot locate real toys then allow participants to cut out pictures of toys from a catalog or sale paper.

2. Have markers and flip chart paper or poster board available for each pair of participants.

Conducting the Activity

1. Brainstorm geometric shapes. Draw and label shapes on the board or flip chart. Review properties of the shapes.

2. Allow participants to choose a partner.

3. Give each pair of participants a sheet of flip chart paper and several markers. Explain that they are going make a chart of the different shapes used in the design and manufacture of a toy.

4. Explain that the chart should contain a picture of each geometric shape used, the name of the shape, and how the shape was used. Advise participants that shapes may be used more than once.
5. Give each pair of participants a toy or let participants choose a toy.

6. Ask participants to look carefully at their toy to identify the different geometric shapes used in making the toy. As they identify the different shapes they should draw it on their chart paper and identify how the shape was used in the manufacture of the toy. You may need to demonstrate what you expect participants to do.

7. Allow participants to share their charts with the class.

8. Discuss which shapes tend to be used the most/least.
Activity 15.7: Graphed Comparisons

Knowing how to read and interpret data is an important life skill. We are bombarded daily with all kinds of graphed comparisons, including statistics that jump out at us from the pages of daily newspapers and from TV screens. In this activity participants sharpen their understanding of graphs and improve their graph reading skills.

Preparation

1. Have graph paper and markers or colored pencils available.
2. Collect several sample line graphs from newspapers or magazines. Choose samples that are considered to have all the elements of a “great” line graph and several samples of line graphs that are missing an important component of a good graph.
3. Have available computers with Internet access or prepared handouts for data collection. You may want to identify several sites prior to the activity in case participants have problems finding appropriate data.

Conducting the Activity

1. Review the elements of a line graph. Draw a large, blank graph on the board. Participants point out the x- and y-axes. Participants brainstorm possible data that could be displayed in a line graph and a title for each set of data. For example: the number of people visiting Grandfather Mountain each year for 10 years with possible title, “Tourism Declines at Popular Attraction.”
2. Review the importance of choosing a scale for the x- and y-axes that will clearly show the data. Participants discuss possible
scales for their brainstorming topics. For example: Suppose an average of 10,000 people visit Grandfather Mountain each year. What would be a good scale? Would you change the scale if only an average of 200 people visit each year?

3. Discuss what makes a graph good or bad? Discuss the sample graphs, both the good and bad graphs. Be sure all the elements of the graphs are discussed, i.e., title, scale, labels, visual appeal, readability, etc.

4. Ask participants to search the Internet for a Web page that shows the performance history of their favorite sports team. Participants look for the number of team wins over a period of years.

5. Allow time for participants to search and collect data from the Internet and design a line graph depicting the data collected.

6. Invite participants to create another graph using performance from another team. Explain that the second graph may be a colorful bar graph, picture graph, or pie chart.

7. Let participants assess their own graphs. Have they used appropriate scales? Does each graph show all the data the participant wanted to show?

8. Have participants choose a partner, exchange graphs, and explain what is shown on the partner’s graph.

9. Review and discuss. What are the elements of line graphs? Do the axes have to be labeled? Why? Compare and contrast elements of different graphs (line, bar, picture, pie). When is one type of graph better than another? Do graphs help people understand information better?
Activity 15.8: Techin’ Up Your Teaching

Technology is a viable, necessary tool that can enrich and enhance the student’s learning experience. When applications of technology are used in concert with the curriculum and instructor skills are appropriately developed, the instructional experience is improved and higher achievement the result. The focus of this activity is to provide experiences that allow instructors to apply technology in the teaching of mathematics.

Preparation

1. Review and update the Internet cites listed on the “Math Websites” and “Math Web Quests” handouts. Note: all listed sites were functional as of December, 2004. You may want to add additional sites in chapter 16.
2. Make copies of the updated handouts for each participant.
3. Arrange access to a computer lab with Internet access. Participants can work in pairs if individual computers are not feasible.

Conducting the Activity

1. Distribute the “Math Websites” handout.
2. Allow participants time to explore websites from the handout.
3. Participants select 1 or 2 activities from their website “journey” applicable to their particular classroom.
4. Instructors discuss their website “journey” and share a math activity or idea with the group.
5. Discuss Web Quests and how they can be used as a teaching tool.

6. Distribute the “Math Web Quests” handout.

7. Participants select a Web Quest to explore and evaluate.

8. Participants evaluate the Web Quest and share their findings.

9. Debrief and discuss how Websites and Web Quest could be used with Adult Basic Skills students.

10. Plan follow-up sessions to share experiences about integrating technology into their teaching.

*We are living in a new economy—powered by technology, fueled by information, and driven by knowledge.*
Math Websites

www.funbrain.com
This site contains interactive games for basic skills.

www.Japanese-online.com
This site contains math problems translated from Japan’s Junior High School Admissions test. These problems could be used as weekly challenge problems.

www.moneyopolis.com
This site is designed to teach financial terms and concepts in a game format. Learners receive money for correct answers and strive to make as much money as possible.

http://mathforum.org/library/drmath/drmath.middle.html
Mathforum is a site that allows participants to post questions about any math topic and receive answers from math experts. Learners can also review previously asked questions and responses.

http://www.neirtec.org
This site offers games for the following topics: integers, fractions, decimals, percents, GCF, LCM, prime factorization, ratios, rates, proportions, geometric figures, perimeter, area, volume, Pythagorean Theorem, patterns, and much more.

http://illuminations.nctm.org
This site is supported by the National Council for Teachers of Mathematics. The factor game can easily be modified for use in the classroom.
Math Web Quests

http://www.shodor.org/interactivate/activities/index.html#num
Multiple interactive websites with links form activities ranging from probability to order of operations.

www.42explore.com
Contains many topics for educators—not just math.

http://www.meridian.wednet.edu/~dshick/webquest.html
Web Quests with interactive links that allow different and varied projects. Highly recommended.

http://www.edina.k12.mn.us/creekvalley
This web site has compiled exceptional links with interactive Web Quests.

March Madness WebQuest

http://www.sbzinak.com/webquest
Budget Web Quest that learners use to establish and maintain a budget. Learners research the kind of job they want and base a budget on that income.
Part 3

Resources
Internet Resources

Dianne B. Barber
Elizabeth A. Johnston

There are many little ways to enlarge your world.
Love of reading is the best of all.
Jacqueline Kennedy
This chapter is an annotated list of useful Internet resources related to teaching and learning in Adult Basic Skills. These resources were selected to complement the other chapters of this manual for those professionals who want additional research-based information and materials to enhance their teaching, learning, and training endeavors.

The list is organized alphabetically by heading. Some items pertain to learning activities while others refer to articles or publications of interest; website address included. It is not meant to be exhaustive but rather a concise presentation of the many potentially helpful and interesting resources available. All listed websites were functional as of December, 2004.

**Adult Education Resource and Information Service (ARIS)**

Australia is an international voice in adult numeracy education. This site gives an overview of recent developments in numeracy and literacy education in Australia. It is a “one-stop” information service for materials, resources, articles, and related links in numeracy and literacy.

**Adults Learning Math Newsletter**
http://www.alm-online.org/Newsletters/ALM-Newsletter.htm

This electronic newsletter, published three times per year, contains a variety of items related to mathematics for Adult Basic Skills. It includes papers, articles, announcements, book reviews, and other entries relevant to adults learning mathematics. The editorial staff consists of representatives from Australia, the Netherlands, and Denmark.

**Adult Numeracy Core Curriculum**
http://www.basic-skills.co.uk

In the late winter of 2001, the United Kingdom published its new curriculum documents for adult numeracy. The entire document is available at this site. The site links to features of the new standards and guidelines for Adult Basic Education in the United Kingdom.
Adult Numeracy Instruction: A New Approach

This is the participant packet from the videoconference Adult Numeracy Instruction: A New Approach authored by Gal Iddo (1994) and published by The National Center on Adult Literacy. It 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.

Adults Numeracy and Maths On–line Project (ANAMOL)

ANAMOL is an Australian site dedicated to providing a forum for adult numeracy practitioners to exchange information, resources, and opinions. Links include Teaching Ideas and Conversations About Teaching.

Adult Numeracy Network
http://shell04.theworld.com/std/anpn/

This site is devoted exclusively to numeracy. It is for numeracy practitioners around the world. It includes a numeracy discussion group, activities, and resources.

Adult Numeracy Network, Boston Branch
http://www2.wgbh.org/MBCWEIS/LTC/CLC/numintro.html

This site contains resources and learning activities for Adult Basic Skills practitioners. About Today’s Date and Puzzle of the Month are two activities. It would be worthwhile to investigate the activities and resources available at this site.

AlphaPlus Center
http://www.alphaplus.ca/mainframe.htm

A wealth of items from Ontario and abroad form the comprehensive collection of resources, materials, links, discussions, and current events in the world of numeracy and literacy.
Assessing Mathematical Knowledge of Adult Learners: Are We Looking at What Counts? NCAL Technical Report TR98–05
http://literacyonline.org/products/ncal/pdf/TR9805

Adult students’ numeracy skills are typically assessed at various points during instruction for a variety of purposes, including student placement, informing instructional decisions, and measuring student learning. However, the assessment instruments available may not be adequate for providing interpretable and useful information to instructors, program directors, or learners. The authors of this report advance a set of principles that reflect psychometric concerns and current research policies. These principles can be used to evaluate existing assessment practices and guide the development of new assessment models. Commonly used assessment tools are examined in light of these principles and are found wanting. The authors suggest alternative items and strategies.

Canadian Literacy Enhancement Society
http://www.literacyplus.ca

This Canadian site offers activities, tools for tutors, and resources for numeracy and literacy practitioners. It contains links to many Canadian literacy sites.

Coping with Math Anxiety

*Coping with Math Anxiety* is written by a math instructor for students and instructors. This site defines math anxiety, suggests strategies to overcome math anxiety, examines the roots of math anxiety, and dispels some commonly believed myths about math.

GED 2002 Teachers Handbook, Florida
http://www.aceofflorida.org/ged

This site offers extensive information and materials such as a printable Teachers’ Handbook and extensive lesson plans using realia for all five GED testing areas. It offers two formats: view materials online or a printer-friendly version.
Framework for Adult Numeracy Standards
http://shell04.theworld.com/std/anpn//framewk.html

This paper, authored in 1996 by the Adult Numeracy Network, was funded by the National Institute for Literacy and is subtitled, *The Mathematical Skills and Abilities Adults Need to Be Equipped for the Future.* It contains the research and methodology behind the creation of the adult numeracy content, and process themes built upon the *Massachusetts Adult Basic Education Math Standards.*

Inclusive Teaching
http://depts.washington.edu/cidrweb/inclusive/diversify.html

Need to diversify your teaching style? This website gives teachers helpful hints on how to change their teaching style and lists resources for instructors to first assess their teaching style then diversify it.

Issues and Challenges in Adult Numeracy NCAL Technical Report TR9315

This technical report presents a study that addresses the need for a strong numeracy component in adult literacy programs. It has four major sections: Mathematics Education for Adults; Perspectives on Numeracy; Toward Defining Numeracy; and Conclusions and Implications. Questions include: Is there a certain level of mathematical knowledge that qualifies a person as numerate? What does it mean to act in a numerate way? What links should be maintained between literacy and numeracy instruction? What specific skills should be emphasized in numeracy instruction?

Laubach Literacy
http://www.laubach.org/home.html

This site may be helpful in that it provides descriptions and order information for Laubach materials from the New Readers Press. Since many literacy programs use Laubach materials, this site provides an easy way to access information on-line about Laubach resources for numeracy and literacy.
Learning Styles
http://www.d.umn.edu/student/loon/acad/strat/lnsty.html

This is a web page from the University of Minnesota’s Handbook. It has a summary of learning styles. It also delves into the theories behind different learning styles. It includes a brief article that describes students’ learning styles.

Learning Styles Questionnaire Index
http://www.engr.ncsu.edu/learningstyles/ilsweb.html

Not only does this site have a short questionnaire that determines your personal learning style, but it also has a description of each learning style and suggestions to help people better adjust to different learning situations.

Math Anxiety
http://www.math.com/students/advice/anxiety.html

This website has numerous study tips and practical advice needed to overcome math anxiety. It links to other sites that have helpful tools such as formulas and tables.

Math in Daily Life
http://www.learner.org/exhibits/dailymath/

This site provides text-based commentary on applications of numeracy in everyday situations, including savings and credit, home decorating, population growth, etc. Some hands-on activities are included. Learners with a sufficient reading level may find these applications interesting supplements to text-based work, and instructors could borrow from the scenarios to illustrate concepts.

Math Forum
http://forum.swarthmore.edu

The Math Forum is an extensive site with many links, including Student Center, Teachers’ Place, and Parents and Citizens. It is not directed specifically to adult educators, but it has some interesting generic information. The link to Ask Dr. Math offers explanations to universal frequently asked questions in
mathematics at a variety of levels. Also, there is a section on “classic” problems that could be suitable for group work or “Problem of the Week” activities.

**Math, Numeracy, Resources, and Discussions**  

Much time could be spent at this site by both instructors and learners. It is a source of interactive lessons, puzzles, homework help, message boards, and much more. The website links to both topic-specific resources and subtopics: Real World Connections, Parents Place, Teacher Talk, etc. Adult learners and instructors will benefit from visiting this interesting site.

**Math Word Problems For Children**  
[http://www.mathstories.com](http://www.mathstories.com)

Do not be misled by the name. Though some of the worksheets available on this site are aimed at elementary school children, many are suitable for use with learners of any age. The worksheets contain not just answers but solutions at the bottom of each page. The content and level of worksheets varies and are updated from time to time. This site is a great source of supplemental word problems for numeracy instructors.

**Measure 4 Measure**  
[http://www.wolinskyweb.com/measure.htm](http://www.wolinskyweb.com/measure.htm)

Measure 4 Measure offers students and instructors the opportunity to explore a collection of Internet math sites that estimate, calculate, evaluate, and translate. The site has three main areas: Science Math, Health Math, and Finance Math. Some of the links offer informational literature; and some are cute and quirky. One site calculates all angles, whereas another calculates the advantages of not smoking.

**Multiple Intelligences**  
[http://www.thomasarmstrong.com](http://www.thomasarmstrong.com)

The theory of multiple intelligences was developed in 1983 by Dr. Howard Gardner, professor of education at Harvard
University. It suggests that the traditional notion of intelligence, based on IQ testing, is far too limited. Instead, Dr. Gardner proposes eight different intelligences to account for a broad range of human potential in children and adults. This site has a link for multiple intelligences that provides general background information about the theory of multiple intelligences as well as numerous practical strategies for using multiple intelligence theory in learning and teaching.

**National Adult Literacy Database (NALD)**  
http://www.nald.ca

NALD is a comprehensive Canadian site for adult educators devoted to adult literacy and numeracy. The audience includes literacy and numeracy instructors, volunteers, and administrators. The site includes events, newsletters, articles, resource lists, and more. It is easy to navigate and also provides a forum for literacy discussion. At times there are adult education-related surveys posted directly on the site.

**Numeracy/Mathematics–CD ROMs**  
http://www.neufeldmath.com

Neufeld Learning Systems, Inc. maintains this website to showcase its collection of mathematics software. Compact discs are available for a variety of topics, and previews may be downloaded for review. Worksheets to support the CD can also be viewed.

**Ohio Mathematical Planning Committee**  
http://archon.educ.kent.edu/Oasis/Resc/Educ/numthe.html

In response to the development of standards for adult numeracy programs, this paper investigates each of the seven content and process themes developed by the Adult Numeracy Network. Included under each theme is a description and commentary on the related implications for teaching and learning.
Project Based Teaching and Learning WWW Links

This site has numerous links and resources for teachers interested in project-based learning. There is also a list of ideas for teacher projects.

Quantitative Literacy Bibliography
http://www.stolaf.edu/other/ql/publ.html

From 1940 to 1999, this site includes a chronological list of publications related to numeracy. The content of most entries is summarized.

Science and Numeracy Special Collection
http://literacynet.org/sciencelincs

This site originates from the Literacy Information and Communication System (LINCS), a cooperative electronic network affiliated with the National Institute for Literacy. The Science and Numeracy Special Collection includes a link to a student/learner section that contains many interactive activities suitable for all levels of Adult Basic Skills learners.

Sure Math: Teaching Problem Solving Techniques
http://www2.hawaii.edu/suremath

This site offers “reliable problem solving in all subjects that use mathematics for problem solving. Algebra, Physics, Chemistry – from grade school to grad school and beyond.” It includes a short guide to lesson plans for problem solving.

Teaching Styles
http://www.indstate.edu/ctl/styles/tstyle.html

This is a useful website by Indiana State University that provides teachers with an overview of teaching styles, a test for teachers to determine their teaching styles, and a curriculum planning guidebook organized by teaching styles.
Using Technology and Real World Connections to Teach Secondary Mathematics Concepts
http://www.enc.org/features/focus/archive/realworld/document.shtm?input=FOC-000706-index

This article advocates the use of technology to connect mathematics to real life. The authors give examples of how teachers can connect mathematics to geology, history, and economics. Even though it is written for the high school audience, the material can easily be adapted for use in Adult Basic Skills.

Walter McKenzie’s Multiple Intelligences Page
http://surf aquarium.com/MI/

This website is slightly on the wacky side, but it contains many useful activities that explore all intelligences. Author Walter McKenzie also has a discussion group on the site where he answers questions about multiple intelligences.

Worksheets for Learners
http://www.schoolhousetech.com

This site allows users to create practice worksheets for basic academic skills in both numeracy and literacy. Some topics are downloadable; others must be purchased, but a free trial is available. The worksheets can be customized in terms of the level of difficulty and appearance.
Mathematical Terms

Dianne B. Barber

*The Universe is a grand book which cannot be read until one first learns to comprehend the language and become familiar with the characters in which it is composed. It is written in the language of mathematics.*

*Galileo*
Introduction

Adult Basic Skills students often struggle with the language of math. For many, it is like learning a foreign language. This chapter includes explanations of many mathematical terms in easy-to-understand language and is illustrated with simple diagrams. It contains terms from all levels of Adult Basic Skills numeracy, beginning math through algebra, geometry, and statistics.

This listing of Math Terms had its beginnings when I was a math instructor. Often students knew how to perform the math operations but did not know (or understand) the vocabulary. I found that when I made sure that students knew the vocabulary associated with the mathematical concepts they performed better on assessments and tests. It was helpful for students to make index cards with the vocabulary words encountered in math lessons. On these cards the students would write the mathematical definition and then write the definition “in their own words.” On the back of the card I would have the students write their own test question demonstrating how that term might be used on a test. Over time their stack of cards grew. When it came time to review for a test each student had their own review test by using the problems on the back of their cards. In lab they often worked together to be sure they could do the problems that other students had written.

The terms may also be used to make games such as bingo or concentration. Students always enjoy playing games. Students often make remarks such as, “It doesn’t feel like I’m learning when we play these games. For me, math is ALWAYS hard work.” “I understand math because you let us play these games.”
2-D, 3-D

two-dimensional, three-dimensional. Having two or three dimensions respectively.

absolute value

the distance a number is from 0 on the number line

acute angle

an angle of less than 90°

acute triangle

a triangle with three acute angles

algebraic expression

a mathematical statement involving variables and/or numbers written in words or symbols, e.g. 3a + 5 or six plus seven times a number

analog clock

usually has 12 equal divisions around the perimeter/ circumference, labeled 1 to 12 to represent hours. It has two hands that rotate around the center. The hour hand completes one revolution in 12 hours and the minute hand completes one revolution in one hour.

angle

a configuration of two line segments meeting at a point. The term is often used for the measure of rotation from one of the line segments to the other. In this sense, a right angle measures 90°, an acute angle is less than 90°, an obtuse angle is greater than 90° but less than 180°, and a reflex angle is greater than 180°.

approximation

a result that is not exact but sufficiently close to be useful in a practical context. Verb: approximate. Adverb: approximately.
area

a measure of a surface. Measured in squares, e.g. square inches (in\(^2\)), square feet (ft\(^2\)), square centimeters (cm\(^2\)), square meters (m\(^2\)).

area of circle

area = \(\pi \times \text{radius}^2\)

area of rectangle

area = length \times width

area of triangle

area = \(\frac{1}{2} \times \text{base} \times \text{height}\)

associate property

grouping does not matter in addition or multiplication, e.g., for numbers \(a\), \(b\), and \(c\); \(a + (b + c) = (a + b) + c\) and \(a \times (b \times c) = (a \times b) \times c\)

average

sometimes used synonymously with arithmetic mean, e.g., average = sum of quantities \(\div\) number of quantities

average speed

average speed = total distance \(\div\) total time

bar chart

a statistical diagram made up of bars. Frequencies are represented by bars of equal width where the lengths are proportional to the frequencies. The bars may be presented vertically or horizontally.

binominal

an algebraic expression containing two terms, e.g., \(2a + 3b\)

bisect

cut exactly in half

bisector

a line which divides another line or an angle exactly in half

block graph

a statistical diagram made up of blocks. In its simplest form, where the class intervals are equal and rectangles have bases of the same size, the block graph can be considered as a bar chart, and the length of each rectangle represents the total in each class.

borrow

to regroup from a greater place value to a lesser place value in order to subtract, e.g., one ten to ten ones
**calculate efficiently**  use knowledge of number systems and operations, e.g., use multiplication rather than repeated addition. In the context of using tools, to use available operations and functions, e.g., memory and constant functions on a calculator, sum formula in a spreadsheet for a range of cells, rather than addition of individual cells.

**cancel**  divide the numerator (top) and denominator (bottom) of a fraction by the same number to make a smaller fraction

**capacity**  volume, i.e., a measure in three-dimensional space, applied to liquids, materials that can be poured, or containers. Units include cubic inches (in$^3$), cubic feet (ft$^3$), cubic centimeters (cm$^3$), cubic meters (m$^3$). Note: a liter is 1000 cm$^3$ (the volume of 1 kg of water).

**cardinal number**  a counting number, i.e., one, two, three, etc.

**carry**  to regroup from a lesser place value to a greater place value in order to add, e.g., ten ones to one ten

**chart**  visual organization and presentation of data in rows and columns

**circumference**  the perimeter of a circle, i.e., the distance all the way around a circle; if the radius of a circle is "r" units, and the diameter is "d" units, then the circumference is $2\pi r$ or $\pi d$

**clockwise**  moving the same direction as the hands of a clock move

**coefficient**  the number in front of a variable, e.g., for the term $4a$ the coefficient of $a$ is 4

**combined events**  a set of independent events with a single outcome. An independent event does not influence a subsequent event. For example, one throw of a die does not influence a second throw. Two throws of a die is a combined event with 36 possible outcomes ($6 \times 6$). The probability of throwing two sixes is $1/36$. 
<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>common</td>
<td>an adjective used to describe units, instruments, measures, date formats, etc. that are widely used in everyday life in non-specialist contexts</td>
</tr>
<tr>
<td>common fraction</td>
<td>a fraction where the numerator and denominator are both integers. Also known as a simple or vulgar fraction.</td>
</tr>
<tr>
<td>commutative property</td>
<td>order does not matter in addition or multiplication, e.g., $2 + 3 = 3 + 2$ and $2 \times 3 = 3 \times 2$. Subtraction and division are not commutative.</td>
</tr>
<tr>
<td>complementary angles</td>
<td>angles that add up to $90^\circ$</td>
</tr>
<tr>
<td>composite shape</td>
<td>an irregular shape which can be partitioned into two or more regular or simple shapes, e.g., an L-shape made up of two rectangles</td>
</tr>
<tr>
<td>congruent</td>
<td>two or more figures that are the exact same shape and the exact same size</td>
</tr>
<tr>
<td>continuous data</td>
<td>data resulting from measurement, e.g., length, temperature. Continuous data can take any value between two values, and can only be measured approximately to a certain degree of accuracy. Continuous data are usually represented by a line.</td>
</tr>
<tr>
<td>consecutive numbers</td>
<td>numbers which follow one another, e.g., 4, 5, 6 are consecutive numbers; 1, 3, 5 are consecutive odd numbers; and 2, 4, 6 are consecutive even numbers</td>
</tr>
</tbody>
</table>
coordinates

ordered pairs; the x coordinate comes first; then the y coordinate; coordinates are always written in pairs within parentheses with a comma between the numbers, e.g., (3,5) where 3 is the x coordinate and 5 is the y coordinate.

counter clockwise

moving in the opposite direction of the hands on a clock.

cube

(1) a three-dimensional figure with six square faces

(2) a number multiplied by itself and then by itself again, e.g., the cube of 3 is $3 \times 3 \times 3$; cubed is written to the power of three, e.g., $2^3 = 2 \times 2 \times 2$

cylinder

a circular prism

data

information of a quantitative nature consisting of counts or measurements; where they refer to items or events that are separate and can be counted, the data are discrete; where they refer to quantities such as length or capacity that are measured, that data are continuous. Singular: datum.

decimal

relating to base ten. Most commonly used synonymously with decimal fraction, where the number of tenths, hundredths, thousandths, etc. are represented as digits following a decimal point. The decimal point is placed at the right of the units column. Each column after the decimal point is a decimal place. For example, the decimal fraction 0.275 is said to have three decimal places. The system of recording with a decimal point is decimal notation. U.S. currency is based on the decimal system.

decrease

to make smaller

denominator

the bottom number of a fraction; tells the number of parts in a whole.
diagonal: a straight line from one corner of a figure to another corner, going across the space inside.

diameter: the distance across the middle of a circle; the diameter is twice the radius, i.e., \( d = 2r \)

difference: the answer to a subtraction problem, e.g., the difference between 3 and 5 is \( 5 - 3 = 2 \).

digit: one of the symbols of a number system, i.e., most commonly the symbols 0, 1, 2, 3, 4, 5, 6, 7, 8, and 9. For example, the number 38 is a two-digit number, but there are three digits in 3.75. The position of the digits conveys place value.

digital clock: 12-hour clock that displays time in hours past midnight and midday and uses a.m. and p.m. to differentiate.

direct proportion: two quantities or variables are in direct proportion when they increase or decrease in the same ratio. For example, if 3 apples cost $1.00 and 6 apples cost $2.00, then cost is in direct proportion to quantity, i.e., they both double, or both halve; expressed mathematically as \( y = kx \) where \( k \) is constant.

discrete data: data resulting from a count of separate items or events, e.g., number of people.

distribution: in recording data, the way values in a set of observations are arranged.

distribution table: a statistical table showing the number of items in each group, sometimes called a frequency table.

distributive property: Multiplication is distributive over addition and subtraction.
dividend  the number being divided into equal parts

\[
\frac{\text{quotient}}{\text{divisor}} = \text{DIVIDEND}
\]

divisor  the number divided into the dividend

\[
\frac{\text{quotient}}{\text{DIVISOR}} = \text{dividend}
\]

equal angles  angles that have the exact same measure

equation  a mathematical statement that says two or more expressions are equal

equilateral triangle  a triangle with three equal sides and three equal angles

\[
\begin{array}{c}
60^\circ \\
60^\circ \\
60^\circ \\
\end{array}
\]

equivalent fractions  fractions of equal value. For example, 6/12, 3/6, and 1/2 are equivalent.

estimate  to arrive at a rough answer by calculating with suitable approximations for numbers

evaluate  to work out the value of an expression when numbers have been substituted for variables

(an expression)

event  used in probability to describe the outcome of an action or happening

exponent  the number of times a number is multiplied by itself

\[
4^6 = (4 \times 4 \times 4 \times 4 \times 4 \times 4)
\]

expression  a mathematical statement involving variables and/or numbers written in words or symbols, e.g., length x width, a x b, or ab

factor  a number that divides evenly into another, e.g., 24 = 3 x 8, so 3 and 8 are factors of 24

A prime factor is a factor that is a prime number.
factoring: the process of expressing a given number (or expression) as the product of two or more numbers (or expressions)

familiar: describes contexts, situations, numbers, measures, instruments, etc. of which the learner has some prior knowledge or experience

formula: any identity, general rule or mathematical law; a sentence in which one variable is given in terms of other variables and/or numbers

fraction: a way of showing (expressing) parts of a whole

frequency table: a statistical table showing how many things are in each group, sometimes called a distribution table

graph: visual representation comparing data from different sources over time

grouped data: observed information arising from counts and grouped into non-overlapping intervals, e.g., number of people in different age groups with intervals 0-9, 10-19, 20-29, 30-39, 40-49, etc.

hypotenuse: the longest side of a right triangle, the side opposite the right angle

improper fraction: a fraction in which the numerator (top) is equal to or larger than the denominator (bottom)
imperial unit  
a unit of measure.  
Units include inch,  
foot, yard, mile,  
acre, ounce, pound,  
stone, ton, pint,  
quart, and gallon.

increase  
to make bigger

integer  
any positive or negative whole numbers including zero

intersection  
where two or more lines meet or what two or more  
items have in common

inverse operations  
operations that, when they are combined, leave the  
entity on which they operate unchanged. Inverse  
operations include addition and subtraction  
(3 + 4 – 4 = 3) and multiplication and division  
(3 x 4 ÷ 4 = 3).

isosceles triangle  
a triangle with two equal sides and two  
equal angles (remember the angle that  
is between the two equal sides is NOT  
one of the equal angles)

like fractions  
fractions that have the same denominator

line graph 
a diagram showing a  
relationship between two  
variables
line symmetry  also reflective symmetry. The property of a shape where one half is a reflection of the other; the ‘mirror line’ is the axis of symmetry or line of symmetry.

lowest terms  no number will equally divide both the numerator and denominator

mass  a fundamental characteristic of a body, relating to the amount of matter within it. Mass differs from weight. Under certain conditions a body can become weightless, whereas mass is constant.

mean  a measure of average. The arithmetic mean is the sum of quantities divided by the number of quantities. For example, the arithmetic mean of 5, 6, 14, 15, and 45 is $(5 + 6 + 14 + 15 + 45) \div 5 = 17$.

measures of central tendencies  a statistic describing a typical value of a numerical data set; i.e., mean, median, mode

median  a measure of average. The middle number or value when all are arranged in order of size. For example, the median of 5, 6, 14, 15, and 45 is 14. Where there is an even number of values, the median is the mean (average) of the two middle values. For example, the median of 5, 7, 7, 8, 14 and 45 is $(7 + 8) \div 2 = 7.5$.

mental math  strategy for finding an answer without writing or using a calculator

metric  relating to the decimal system of measurement based on the meter, kilogram, and second

metric unit  unit of measurement in the decimal system. Metric units include meter, centimeter, millimeter, kilometer, gram, and kilogram.
mixed fraction  a whole number and a fractional part expressed as a common fraction, e.g., 1 2/3 is a mixed fraction; also known as a mixed number.

mixed number  a whole number and a fractional part expressed as a common fraction, e.g., 1 2/3 is a mixed number; also known as a mixed fraction.

mode  a measure of average. The most frequently occurring number in a set of data. For example, the mode of 5, 6, 6, 7, 8 and, 10 is 6.

monomials  an expression with one term.

multiple  any number that has a given number as a factor is called a multiple of that factor, e.g., 12 = 6 x 2, 36 = 6 x 6 and 60 = 6 x 10; so 12, 36, and 60 are all multiples of 6.

natural number  a positive integer; a positive whole number.

negative number  a number less than 0.

non-standard unit  unit of measure which is not fixed or widely agreed upon, e.g., pace—each person has a different pace.

number bond  a pair of numbers with a particular total, e.g., number bonds to ten means all pairs of numbers with the total 10.

numeral  a symbol used to denote a number. The Roman numerals I, V, X, L, C, D and M represent the numbers one, five, ten, fifty, one hundred, five hundred, and one thousand. The Arabic numerals 0, 1, 2, 3, 4, 5, 6, 7, 8, and 9 are used in the Hindu-Arabic system giving numbers in the form that is widely used today.
numerator

the top number of a fraction; it tells how many parts of the whole were used

obtuse angle

an angle that measures more than 90° but less than 180°

operation

a means of combining numbers, sets or other elements. Addition, subtraction, multiplication, and division are four operations on numbers.

order of operations

the set of rules for finding the value of mathematical expressions

ordinal number

a term that describes a position within an order, e.g., first, second, third, fourth … twentieth, etc.

origin

the point (0,0) where the x axis crosses the y axis

parallel

always the same distance apart, e.g., parallel lines are always the same distance apart; they do not meet

pattern

a systematic arrangement of numbers, shapes, or other elements according to a rule

percent

out of 100, written%

percentage

a fraction expressed as the number of parts per hundred and recorded using the notation #%, e.g. one-half can be expressed as 50%, the whole can be expressed as 100%
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<tr>
<td>perimeter</td>
<td>the complete distance around the outside of a figure</td>
</tr>
<tr>
<td>perpendicular</td>
<td>at right angles</td>
</tr>
<tr>
<td>pi (π)</td>
<td>the symbol used to denote the ratio of the circumference of a circle to its diameter</td>
</tr>
<tr>
<td>pictogram</td>
<td>a statistical diagram made up of pictures. Suitable pictures/symbols/icons are used to represent objects. For large numbers one symbol may represent a number of objects (one apple may represent 100 bushels); a part symbol then represents a rough proportion of the number (1/2 apple represents 50 bushels).</td>
</tr>
<tr>
<td>pie chart</td>
<td>a statistical diagram shaped like a circular pie, with slices of pie showing amounts. The frequency or amount of each quantity is proportional to the angle at the center of the circle.</td>
</tr>
<tr>
<td>place value</td>
<td>the value of a digit that relates to its position or place in a number, e.g. in 1,321 the digits represent thousands, hundreds, tens, and units respectively. The value of the 1 on the left is one thousand while the value of the 1 on the right is one.</td>
</tr>
</tbody>
</table>
plot  

to represent graphically on a chart

prime number  
a prime number has exactly two factors, itself and 1. For example, 2 has factors 2 and 1, 3 has factors 3 and 1; however 6 is not a prime number because it has factors 2 and 3 in addition to 1 and 6.

probability  
the likelihood of an event happening; a measure of certainty. Probability is expressed on a scale from 0 to 1 either as a fraction, decimal or percent. Where an event cannot happen, its probability is 0 and, where it is certain, its probability is 1. The probability of scoring 1 with a fair die is 1/6 or about .167 or 16.7%.

product  
the answer to a multiplication problem, e.g., the product of 2, 3, and 4 is 24 (2 x 3 x 4)

property  
any attribute, e.g., one property of a square is that all sides are equal

proportions  
an equation made up of two equal ratios

Pythagorean Theorem  
measure of the hypotenuse in a right triangle, the sum of the measure of the legs = the sum of the square of the hypotenuse, e.g., leg$^2$ + leg$^2$ = hypotenuse$^2$ most often written as a$^2$ + b$^2$ = c$^2$
quadrilateral  
a polygon with four sides and four interior angles

quotient  
an answer to a division problem

\[
\text{QUOTIENT} = \frac{\text{dividend}}{\text{divisor}}
\]

radius  
the distance from the center of a circle to the circumference; half the diameter

range  
a measure of spread in statistics; the difference between the least and greatest in a set of numerical data

diameter  
the distance across the circle, passing through the center

temperature  
how hot or cold something is

ratio  
a comparison of quantities of the same kind, written a:b. For example, a mixture made up of two ingredients in the ratio 3:1 is 3 parts of the first ingredient to 1 part of the second; the first ingredient makes up 3/4 of the total mixture, and the second makes up 1/4 of the total.

reciprocal  
the reversal of a fraction, to turn upside down, e.g., the reciprocal of 2/3 is 3/2

rectangle  
a quadrilateral (four-sided polygon) with four right angles. The pairs of opposite sides are equal. Adjective: rectangular.

reflex angle  
an angle that is more than 180 degrees but less than 360 degrees

regular  
a polygon is a regular polygon if all the sides are equal and all the internal angles are equal, e.g., a regular quadrilateral is a square. When referring to a shape, the adjective ‘regular’ refers to common 2-D and 3-D shapes whose areas can be found using a formula, e.g., a rectangle, circle, cylinder.

revolution  
all the way around, i.e. 360°
right angle an angle of exactly 90°; one-quarter of a complete turn

roman numerals most common used roman numerals are

IV=4 (1 before 5), IX=9 (1 before 10), VII=7 (5 + 2 = 7)

rotation turning a figure about a point, the point is called the center of rotation

round (verb) to express a number or measurement to a required degree of accuracy, e.g., 764 rounded to the nearest ten is 760

scale a measuring device usually consisting of points on a line with equal intervals

scalene triangle a triangle with no equal sides and no equal angles

scientific notation a way of writing very large numbers and very small decimals in which the numbers are expressed as the product of a number between 1 and 10 and a power of 10

sequence a succession of terms formed according to a rule, in which there is a definite relation between one term and the next and between each term and its position in the sequence, e.g. 1, 4, 9, 16, 25, etc.
**sign**  
a symbol used to denote an operation, e.g., addition sign +, subtraction sign –, multiplication sign x, division sign ÷. In the case of directed numbers, the positive + or negative – sign indicates the direction in which the number is measured from the origin along the number line.

**simplify**  
work out to give the shortest possible answer

**square number**  
a number that can be expressed as the product of two equal numbers, e.g., 25 = 5 x 5, so 25 is a square number

**square unit**  
unit used to measure the area of a two-dimensional figure; units needed to cover a surface

**standard unit**  
units that are agreed upon throughout a community, e.g., the foot is a standard measure of length. Non-standard units are not widely agreed upon.

**straight angle**  
an angle that measures 180 degrees

**substitute**  
to assign a value to a variable

**sum**  
answer to an addition problem

**supplementary angles**  
angles which add up to 180 degrees

**symbol**  
a letter, numeral, or other mark that represents a number, an operation or another mathematical idea. For example, V is the Roman symbol for 5 and > is the symbol for “is greater than.”
symmetry  a figure has symmetry if parts can be interchanged without changing the whole. A geometric figure may have reflective symmetry or rotational symmetry. Adjective: symmetrical.

system (of measure) units are defined in a fixed relationship to each other

table an orderly arrangement of information, numbers or letters, usually in rows and columns

tally to make marks to represent objects counted

term one of the parts of an expression, e.g., 3a – 2 has two terms: 3a and -2

translation moving the position of an object so that it looks the same but is in a different place. It does not rotate, only moves left or right or up or down.

trinominal an expression containing three terms, e.g., $3x^2 - 4x + 5$ has three terms: $3x^2$, -4x and 5

unit one, a standard used in measuring, e.g., a meter is a metric unit of length

unit fraction a fraction that has 1 as the numerator and whose denominator is a non-zero integer, e.g., 1/2, 1/3

unit price the cost of one item

unlike fractions fractions with different denominators

variable a letter or symbol used to represent an unknown number

vertex common endpoint of two rays that form an angle
**volume**

the amount of space inside a solid; measured in cubes, e.g., cubic inches (in$^3$), cubic centimeters (cm$^3$)

**weight**

the force with which a body is attracted towards the earth’s center. In non-scientific contexts, often used synonymously with mass (though technically different). Units of weight include pounds (lbs), ounces (oz), kilograms (kg) and grams (g).

**x axis**

the horizontal (across) axis

**x intercept**

the point at which a line crosses the x-axis on a coordinate graph; the ordered pair (x,0)

**y axis**

the vertical (up/down) axis

**y intercept**

the point at which a line crosses the y-axis on a coordinate graph; the ordered pair (0,y)
The mind is not a vessel to be filled. 
It is a fire to be kindled. 
Plutarch


perceptions of effective teaching with those of traditional students. *Continuing Higher Education Review*, 57(3), 147-165.


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