What Mathematics Should Adults Learn? Adult Mathematics Instruction as a Corollary to Two Decades of School Mathematics Reform

Katherine Safford-Ramus
Saint Peter's College
Jersey City, New Jersey, United States of America
ksafford@spc.edu

It has been twenty-five years since the National Commission on Excellence in Education called attention to the condition of education in the United States with its A Nation at Risk: The Imperative for Educational Reform. In 1989 the National Council of Teachers of Mathematics (NCTM) released their Curriculum and Evaluation Standards for School Mathematics. The original Standards were revised in 2000 and last year NCTM released the Curriculum Focal Points, a guidebook concerning the grade level at which specific mathematics content should be taught from pre-school through 8th grade. All of these documents concerned school mathematics.

In the intervening years since 1989, mathematics professional organizations, notably the Mathematical Association of America and American Mathematical Association of Two-Year Colleges, have addressed the issue of mathematics standards for post-secondary institutions, one arena for adults studying mathematics. Outside the mathematics community, others have scrutinized the concepts of "numeracy" and "quantitative literacy." The National Institute for Literacy, the College Entrance Examination Board, and the National Council on Education and the Disciplines have explored the mathematical needs of adults in United States society.

This year, the National Mathematics Panel released its report with recommendations concerning K-12 mathematics education in the United States. This paper highlights elements from the elementary and secondary reform movement that are pertinent to adult students. Points of divergence between the recommendations for school mathematics and the quantitative literacy needs of adults are discussed.

Introduction

Twenty-five years ago, the United States Department of Education published *A Nation at Risk: The Imperative for Educational Reform* sounding an alarm that the United States educational foundations were in grave danger, "eroded by a rising tide of mediocrity that threatens our very future as a Nation and a people" (National Council on Excellence in Education, 1983, p. 5). The National Research Council followed with a trilogy of texts specifically addressing the condition of United States mathematics education (National Research Council, 1989, 1990, 1993). In 1989 the National Council of Teachers of Mathematics (NCTM) released their ground-breaking *Curriculum and Evaluation Standards for School Mathematics.* That was followed by two

additional publications promoting standards for the profession and for assessment (National Council of Teachers of Mathematics, 1991, 1995). The three original *Standards* volumes were revised and consolidated in 2000 (National Council of Teachers of Mathematics, 2000) and last year NCTM released the *Curriculum Focal Points*, a handbook concerning the grade level at which specific mathematics content should be taught from pre-school through 8th grade (National Council of Teachers of Mathematics, 2007). This year, the National Mathematics Panel released its report with recommendations concerning K-12 mathematics education in the United States (National Mathematics Advisory Panel, 2008).

In the intervening years since 1989, other mathematics professional organizations have addressed the issue of standards for post-secondary institutions. The American Mathematical Association of Two-Year Colleges (AMATYC) published *Crossroads in Mathematics: Standards for Introductory College Mathematic Before Calculus* and, recently, *Beyond Crossroads: Implementing Mathematics Standards in the First Two Years of College*. The Mathematical Association of America (MAA) released *Undergraduate Programs in the Mathematical Sciences: CUPM Curriculum Guide 2004* making recommendations for service and mathematics major courses. This year, the MAA released the latest entry in its quantitative literacy sequence, *Calculation vs. Context: Quantitative Literacy and Its Implications for Teacher Education*, which explores the disconnect between the education of prospective teachers and the practical applications of mathematics in adult life.

Those practical applications, called interchangeably "numeracy" and "quantitative literacy" in the reports to be examined, have been explored within and outside the mathematics communities. Within the adult education system, the National Institute for Literacy (NIFL) included mathematics as a key component in its *Equipped for the Future Content Standards*. The College Entrance Examination Board explored the need for adult numeracy in its 1997 publication *Why Numbers Count: Quantitative Literacy for Tomorrow's America*. The National Council on Education and the Disciplines (NCED) followed in 2000 with *Mathematics and Democracy: The Case for Quantitative Literacy.* NCED also sponsored a forum on quantitative literacy in 2001 that was documented in 2003 in *Quantitative Literacy: Numeracy Matters for Schools and Colleges*.

With the exception of the *Equipped for the Future* project, adult mathematics education experts were noticeably absent from the preparation of the standards documents summarized here. A corollary is, by definition, "an immediate consequence or easily drawn conclusion, a natural consequence or result" (Stein, 1975). This paper terms our work as adult educators a corollary to the reforms of the past twenty years because it is primarily subsequent and reactive to the principles proposed by the school and academic establishment. While there is substantial overlap, the recent shift by the National Math Panel towards a traditional view of mathematics education represents a divergence from many of the values we hold for adult mathematics education that challenges the corollary analogy and gives cause to suggest a new and different "theorem" for our students.

School Mathematics

The National Council of Teachers of Mathematics (NCTM) is the largest and most powerful player on the school mathematics field. In their *Principles and Standards for School Mathematics* they describe a curriculum as "A curriculum is more than a collection of activities: it must be coherent, focused on important mathematics, and well articulated across the grades" (NCTM, 2000, p. 14). It should include:

- Foundational ideas like place value, equivalence, proportionality, function, and rate of change
- Mathematical thinking and reasoning skills like making conjectures and developing sound deductive arguments
- Concepts and processes like symmetry and generalization
- Experiences with modeling and predicting real-world phenomena (pp. 15–16)

This definition of curriculum was global and, over time, it became evident that the community could benefit from a more directive NCTM statement suggesting a judicious sequence of topics within the curriculum framework. Furthermore, a mapping of topics to grade levels would provide a consistent timeline for designers, authors, and publishers of curricula. The resulting product, *Curriculum Focal Points for Prekindergarten through Grade 8 Mathematics*, provides "descriptions of the most significant mathematical concepts and skills at each grade level" (National Council of Teachers of Mathematics, 2006, p. 1). From an adult education perspective, I have paired the grade requirements for grades 1 through 8 and presented them as four "levels" that might be useful in an adult basic education setting. Table 1 shows that arrangement.

Table 1. Grades 1 through 8 Focal Points Grouped as Effective Levels

Level One: Grades 1–2

- Develop understandings of addition and subtraction and strategies for basic addition facts and related subtraction facts.
- Develop quick recall of add/subtract facts and fluency with multi-digit addition and subtraction
- Develop an understanding of the base-ten numeration system and place-value concepts
- Compose and decompose geometric shapes
- Develop an understanding of linear measurement and facility in measuring lengths

Level Two: Grades 3–4

- Develop understandings of multiplication and division and strategies for basic multiplication facts and related division facts
- Develop quick recall of multiplication/division facts and fluency with whole number multiplication
- Develop an understanding of fractions and fraction equivalence
- Develop an understanding of decimals, including the connections between fractions and decimals
- Describe and analyze properties of two-dimensional shapes
- Develop an understanding of area and determining the areas of two-dimensional shapes

Level Three: Grades 5–6

- Develop an understanding of and fluency with division of whole numbers, fractions, and decimals
- Develop an understanding of fluency with addition and subtraction of fractions and decimals
- Connect ratio and rate to multiplication and division
- Describe three-dimensional shapes and analyze their properties, including volume and surface area
- Write, interpret, and use mathematical expressions and equations (Algebra)

Level Four: Grades 7–8

- Develop an understanding of and apply proportionality, including similarity
- Develop an understanding of and using formulas to determine surface areas and volumes of three-dimensional shapes
- Analyze two- and three-dimensional space and figures by using distance and angle
- Develop an understanding of operations on all rational numbers
- Analyze and represent linear equations and solve linear equations and systems of same
- Analyze and summarize data sets (National Council of Teachers of Mathematics, 2007)

In 2006, President Bush created a National Mathematics Advisory Panel (NMAP) and charged its members with the task of "relying upon the 'best available scientific evidence' and recommending ways 'to foster greater knowledge of and improved performance in mathematics among American students" (National Mathematics Advisory Panel, 2008, p. xiii). This year, the National Mathematics Panel released its report with recommendations concerning K-12 mathematics education in the United States. Their recommendations for curricular content stressed that there should be "A focused, coherent progression of mathematics learning, with an emphasis on proficiency with key topics" (National Mathematics Advisory Panel, 2008, xvi) with preparation for the study of algebra as its central goal. Those critical topics fell into three groups and were detailed as shown in Table 2:

Table 2. Critical Foundations of Algebra

Fluency with Whole Numbers

- Place value, basic operations, properties, and computational facility with both number facts and standard algorithms, estimation.

Fluency with Fractions

- Positive and negative fractions; representation and comparison of fractions, decimals, and percents; operations on fractions; applications to rates, proportionality, and probability; extension of the fractional notation to algebraic generalization.

Geometry and Measurement

- Similarity of triangles, slope of linear functions, properties of two- and three-dimensional figures using formulas for perimeter, area, and volume (pp. 17–18).

The panel included specific benchmarks for these critical foundations and recommended that they be used to guide the development of curricula. In general, the NMAP benchmarks coincide with the NCTM focal points. Exceptions worth noting are the appearance of signed number operations

in Grade 6 (Level 3) for NMAP, the nominal mention of probability, and complete absence of any discussion of statistics in the NMAP critical foundations.

Algebra for *all* students has long been a battle-cry in the school mathematics community and the NMAP report made it quite clear that this was the culmination of the school mathematics curriculum they envisioned. In their own words, "All school districts should ensure that all prepared students have access to an authentic algebra course and should prepare more students than at present to enroll in such a course by Grade 8" (p. 23). While not decreeing grade level instruction by topic, they expect that all students should have mastered the listed topics by the end of Grade 11 (p. 16). Table 3 lists the NMAP breakdown of algebra topics.

Table 3. Major Topics of School Algebra

Symbols and Expressions
- Polynomial expressions
- Rational expressions
- Arithmetic and finite geometric series

Linear Equations
- Real numbers as points on the number line
- Linear Equations and their graphs
- Solving problems with linear equations
- Linear inequalities and their graphs
- Graphing and solving systems of simultaneous linear equations

Quadratic Equations
- Factors and factoring of quadratic polynomials with integer coefficients
- Completing the square in quadratic expressions
- Quadratic formula and factoring of general quadratic polynomials
- Using the quadratic formula to solve equations

Functions
- Linear functions
- Quadratic functions and their graphs
- Polynomial functions
- Simple nonlinear functions
- Rational exponents, radical expressions, and exponential functions
- Logarithmic functions
- Trigonometric functions
- Fitting simple mathematics models to data

Algebra of Polynomials
- Roots and factorization of polynomials
- Complex numbers and operations
- Fundamental theorem of algebra
- Binomial coefficients (and Pascal's Triangle)
- Mathematical induction and the binomial theorem

Combinatorics and Finite Probability
- Combinations and permutations as applications of the binomial theorem and Pascal's Theorem (p. 16)

Adult Mathematics

Adult mathematics education is offered in the United States through two major systems, adult education and tertiary (post-secondary) education, each of which educates roughly 2 million adult mathematics students a year (Safford-Ramus, 2008, p. 31). Professionals from the adult education sector were not included in the NCTM planning process and were therefore reactive rather than proactive in developing standards for adult basic and secondary mathematics curricula. It was not until the mid-1990's that adult numeracy standards began to appear. The National Institute for Literacy (NIFL) funded the *ABE Math Standards Project* that applied the NCTM *Curriculum and Evaluation Standards* to adult basic education (ABE), adult secondary education (ASE/GED) and workplace education settings (Leonelli and Schwendeman, 1984, p. 5). NIFL incorporated a math standard into their *Equipped for the Future Content Standards* with a decision-making skill termed "Use Math to Solve Problems and Communicate." Table 4 lists the NIFL *EFF* standards.

Table 4. Use Math to Solve Problems and Communicate

Adults function as:

- Citizens/Community Members
- Parents/Family Members
- Workers

Adults use Math to solve problems and communicate:

- Understand, interpret, and work with pictures, numbers, and symbolic information.
- Apply knowledge of mathematical concepts and procedures to figure out how to answer a question, solve a problem, make a prediction, or carry out a task that has a mathematical dimension.
- Define and select data to be used in solving the problem.
- Determine the degree of precision required by the situation.
- Solve problem using appropriate quantitative procedures and verify that the results are reasonable.
- Communicate results using a variety of mathematical representations, including graphs, charts, tables, and algebraic models (Stein, 2000, p. 35).

Action was taken on the local level. In California, the Los Angeles Unified School District married the NCTM *Standards* and the California Department of Education *Mathematics Framework of California Public Schools* their *Goals and Strands for Adult Mathematical Literacy*. Individual researchers incorporated the standards into their adult mathematics programs. As part of a workplace numeracy venture, I designed and taught a basic mathematics curriculum based on the NCTM *Standards* (Safford, 1992). The sequence of topics from that course is included as Appendix A. Concurrently, a group of graduate students at Rutgers designed an algebra course for adults based on the *Standards* and related NCTM documents (Safford-Ramus, 1996, Ramus, 1997). The resulting syllabus is included as Appendix B.

As recently as 2005, the Adult Numeracy Network published *Teaching and Learning Principles* that described a mathematics curriculum for adult learners. Table 5 lists their aspirations for such a curriculum.

Table 5. Adult Numeracy Network *Teaching and Learning Principles* Curriculum

A high quality mathematics curriculum for adult learners should**:**

- Include the concepts of number, data, geometry, and algebra at all levels of learning so that students can develop and connect mathematical ideas.
- Weave together *all* elements of mathematical proficiency—not only procedural fluency, but also conceptual understanding, ongoing sense-making, problem solving, and a positive attitude about learning mathematics.
- Feature worthwhile tasks, such as activities that are drawn from the context of real life experience.
- Develop confidence in using various strategies, such as estimation, mental mathematics, written procedures, and appropriate use of technology.

Professors from tertiary (post-secondary) institutions were included in the development of the NCTM *Standards* but not from the standpoint of teachers of adult students. Their focus in that project was *children* learning mathematics. Just as in the adult education system, work on standards for mathematics instruction in the tertiary system ran consequent, not concurrent, to elementary and secondary research. The term "numeracy" appears less in the literature of collegiate mathematics and is often replaced by "quantitative literacy."

Most adults returning to college enter through the community college portal. The American Mathematical Association of Two-Year Colleges (AMATYC) has published two major works that address standards for mathematics taught at their institutions. The second of these, *Beyond Crossroads: Implementing Mathematics Standards in the First Two Years of College* has the stronger adult flavor, recognizing that the average two-year college student is 29 years old (Blair, 2006, p. 3). The document stresses that all collegiate programs should strive for quantitative literacy and characterizes it in the following way:

Students in all college programs will be expected to do the following:

- Exhibit perseverance, ability, and confidence to use mathematics to solve problems
- Perform mental arithmetic and use proportional reasoning
- Estimate and check answers to problems and determine the reasonableness of results
- Use geometric concepts and representations in solving problems
- Collect, organize, analyze data, and interpret various representations of data, including graphs and tables
- Use a variety of problem-solving strategies and exhibit logical thinking
- Use basic descriptive statistics
- Utilize linear, exponential, and other nonlinear models as appropriate
- Communicate findings both in writing and orally using appropriate mathematical language and symbolism with supporting data and graphs
- Work effectively with others to solve problems

- Demonstrate an understanding and an appreciation of the positive role of mathematics in their lives (Blair, 2006, p. 40).

Members of the four-year college mathematics community, particularly Lynn Steen and Bernie Madison, have also been engaged in defining quantitative literacy although the literature they have produced has often been funded by agencies outside the mathematics community. In 1997, the College Entrance Examination Board published *Why Numbers Count: Quantitative Literacy for Tomorrow's America*. While striving for a working definition of QL, Dossey offers the following descriptors of the mathematics requirements of an adult in US society:

Adult mathematical behaviors can be categorized using six major aspects:
- Data representation and interpretation
- Number and operation sense
- Measurement
- Variables and relations
- Geometric shapes and spatial visualization
- Chance (Steen, 1997, p. 173)

The National Council on Education and the Disciplines (NCED), a group within the Woodrow Wilson National Fellowship Foundation, commissioned a team of educators to examine the interdependence of democracy and quantitative literacy. Their report, *Mathematics and Democracy: the Case of Quantitative Literacy* offered compelling arguments for the citizen of the twenty-first century to possess strong mathematics skills. They saw evidence of numeracy in the modern world in the areas of citizenship, culture, education, professions, personal finance, personal health, management, and work. To service those QL needs, citizens need the numeracy skills detailed in Table 6:

Table 6: Elements of Quantitative Literacy

- *Arithmetic*: Having facility with simple mental arithmetic; estimating arithmetic calculations; reasoning with proportions; combinatorics.
- *Data*: Using information conveyed as data, graphs, and charts; drawing inferences from data; recognizing disaggregation as a factor in interpreting data.
- *Computers*: Using spreadsheets, recording data, performing calculations, creating graphic displays, extrapolating, fitting lines or curves to data.
- *Modeling*: Formulating problems, seeking patterns, and drawing conclusions; recognizing interactions in complex systems; understanding linear, exponential, multivariate, and simulation models; understanding the impact of different rates of growth.
- *Statistics*: Understanding the importance of variability; recognizing the differences between correlation and causation, between randomized experiments and observational studies, between finding no effect and finding no statistically significant effect (especially with small samples), and between statistical significance and practical importance (especially with large samples).
- *Chance*: Recognizing that seemingly improbable coincidences are not uncommon; evaluating risks from available evidence; understanding the value of random samples.

- *Reasoning*: Using logical thinking; recognizing levels of rigor in methods of inference; checking hypotheses; exercising caution in making generalizations (Orrill in Madison and Steen, 2003, pp. 16–17).

In 2001, NCED in cooperation with the Mathematical Association of America (MAA) convened a forum of national and international leaders to discuss the question "Why Numeracy Matters for Schools and Colleges?" The conference proceedings offer a global look at quantitative literacy from the perspective of thirty individuals. The anticipated outcome of the proceedings was to "provide a benchmark discussion from which the needed national conversation can go forward (Orrill in Madison and Steen, 2003, p. viii)." Packer addresses the question "What mathematics should 'everyone' know and be able to do?" by looking at the various roles played by individuals in society: consumer, worker, citizen, and personal. He chose to organize the types of problems adults encounter according to the taxonomy developed by the Secretary's Commission on Achieving Necessary Skills (SCANS) report:

- Planning problems: Allocating money (budgeting), time (scheduling), space and staff.
- Systems and processes problems: Understanding, monitoring, and designing social, physical, or business systems.
- Interpersonal problems: Working in teams, negotiating, teaching, and learning.
- Information problems: Gathering and organizing data, evaluating data, and communicating both in written and oral form.
- Technology problems: Using, choosing, and maintaining equipment of any type (Packer in Steen, 2001, p. 37).

In the intervening years, a loosely knit group of individuals from that conference were joined by colleagues from a variety of disciplines and the National Numeracy Network began. Finally, in 2007 the MAA organized a conference to explore the linkage of quantitative literacy and teacher education. Participants reviewed the QL volumes mentioned earlier as well as a teacher education text, *The Mathematical Education of Teachers* that had been published in 2001 by the Conference Board of the Mathematical Sciences (CBMS). Eight individuals wrote essays that were distributed to participants prior to the conference. In the edited volume that summarizes the conference, Steen summarizes the two main issues that surfaced in the course of the conference, "Two special issues dominated the discussions: the relative roles of mathematics vis a vis other disciplines in the development of numeracy, and the potential of teacher preparation as a tool for enhancing numeracy" (Steen, 2008, p. 11). Predictably, the conference did not produce a laundry list of skills that adults should possess. Instead, each essay addresses specific competencies that the quantitatively literate adult should possess: the ability to argue with numbers, to use fractions and percents in everyday life, to function in the business world, to research and organize quantitative data and to think critically about public issues.

Conclusion

The paths of mathematics education reform for children and adults resemble two highways that join together for a distance then diverge, remaining parallel but distinct. The differences reflect the intrinsic distinction between pedagogy and andragogy. School mathematics must prepare children for all the possible paths that their educational journey might take. Adult mathematics education, on the other hand, is present-directed and offered to individuals who have a clearer

vision of their educational goals. This perceived immediacy may prove to be short-sighted, for example the GED student who just "wants to learn what will be on the test" only to decide later that community college is a new goal. In general, however, adults returning to education are not likely to pursue a career in engineering or any other discipline that requires intricate algebraic or trigonometric skills.

When one considers the school mathematics standards advocated by the National Mathematics Panel this dichotomy becomes striking. The standards put forth by the panel stress the acquisition of increasingly complex mathematics skills from kindergarten through secondary school. While it may not have been their intent, little mention is made of the type of competencies identified by the quantitative literacy folks: problem-solving heuristics, modeling, logic and reasoning, cooperative work, and statistical literacy. It is the disappearance of statistics and downgrading of probability that I find most troubling. In their roles as citizens and workers, adult students are increasingly called on to comprehend statistical data and arguments. The vision of mathematics as a science of patterns is also discouraged in the NMP report yet the interplay of inductive and deductive reasoning in making informed decisions is an important element of adult life.

While the school mathematics and adult mathematics communities have been sharing the same pavement for the past fifteen years, I believe we have reached the point where the roads diverge and we must go our separate ways. This will mean a continuance of research directed towards the refinement of those skills that are of inherent value to both populations while advancing teacher knowledge of materials and methodologies that promote quantitative literacy for our adult students.

References

American Mathematical Association of Two-Year Colleges (1995). *Crossroads in Mathematics: Standards for Introductory College Mathematics before Calculus.* Memphis, TN: AMATYC.

American Mathematical Association of Two-Year Colleges (2006). *Beyond Crossroads: Implementing Mathematics Standards in the First Two Years of College.* Memphis, TN: AMATYC.

Madison, B. L. and Steen, L. A. (2008). *Calculation vs. Content: Quantitative Literacy and Its Implications for Teacher Education.* Washington, D.C.: Mathematical Association of America.

Mathematical Association of America (2004). *Undergraduate Programs and Courses in the Mathematical Sciences: CUPM Curriculum Guide 2004.* Washington, D.C.: MAA.

National Commission on Excellence in Education (1983). *A Nation at Risk: The Imperative for Educational Reform.* Washington, D.C.*:* U. S. Government Printing Office.

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

National Council of Teachers of Mathematics (1991). *Professional Standards for Teaching Mathematics*. Reston, VA: NCTM.

National Council of Teachers of Mathematics (1995). *Assessment Standards for School Mathematics*. Reston, VA: NCTM.

National Council of Teachers of Mathematics (2000). *Principles and Standards for School Mathematics*. Reston, VA: NCTM.

National Council of Teachers of Mathematics (2006). *Curriculum Focal Points for Prekindergarten through Grade 8 Mathematics*. Reston, VA: NCTM.

National Mathematics Advisory Panel (2008). *Foundations for Success: The Final Report of the National Mathematics Panel.* Washington, D.C.: United States Department of Education.

National Research Council (1989). *Everybody Counts: A Report to the Nation on the Future of Mathematics Education*. Washington, D.C.: National Academy Press.

National Research Council (1990). *A Challenge of Numbers: People in the Mathematical Sciences*. Washington, D.C.: National Academy Press.

National Research Council (1993). *Measuring Up: Prototypes for Mathematics Assessment.*. Washington, D.C.: National Academy Press.

Ramus, K. S. (1997). *How the Mathematics Education Reforms Pertain to Undergraduate Curriculum: An Introductory Study of an Experimental Developmental Algebra Course for Adults.* Unpublished doctoral dissertation, Rutgers, the State University of New Jersey, UMI 9717243.

Safford, K. (1992). *Basic Mathematics II for Manufacturing*. West Windsor, NJ: Mercer County Community College. ED351580.

Safford-Ramus, K. (1996). *Beginning Algebra: A Problem-Centered Approach.* Unpublished text.

Safford-Ramus, K. (2008). *Unlatching the Gate: Helping Adult Students Learn Mathematics.* Philadelphia, PA: Xlibris.

Steen, L. A. (ed.) (1997). *Why Numbers Count: Quantitative Literacy for Tomorrow's America.* New York: The College Board.

Steen, L. A. (ed.) 2001. *Mathematics and Democracy: The Case for Quantitative Literacy.* Washington, D.C.: National Council on Education and the Disciplines.

Stein, J. (ed.) (1975). *The Random House College Dictionary, Revised Edition*. New York: Random House.

Stein, S. (2000). *Equipped for the Future Content Standards: What Adults Need to Know and Be Able to Do in the 21st Century.* Washington, D.C.: The National Institute for Literacy.

Appendices

Appendix A: A Basic Mathematics Course Prototype
Basic Mathematics II for Manufacturing (Safford,1992)

Decimal Concepts

- Place value from millions to thousandths
- Standard and expanded notation
- Order and comparison of numbers
- Decimal word problems

Operations

- Addition and subtraction
- Multiplication as repeated addition and area
- Division as repeated subtraction and partitioning
- Multi-operational word problems

Fraction Concepts

- Physical representations of fractions
- Identification of the parts of a fraction by name and meaning
- Rename and compare fractions
- Convert improper fractions to mixed number and vice versa
- Convert a fraction to a decimal, repeating or terminating
- Operations with fractions

Percents

- Physical representations of percent connected to fraction concepts
- Conversion between the three part-whole representations: fractions, decimals, percents
- Percent applications: taxes, interest, increase and decrease

Ratio and Proportion

- Physical representations of ratio and proportion
- Connection to fraction concepts of renaming
- Set up proportional equation and calculate a missing value
- Connection to percent applications
- Rates

Statistics

- The statistical process: gathering, organizing, and representing data, making inferences
- Sampling concepts
- Construct and execute a survey
- Graphs: Line, histogram, pie chart
- Measures of central tendency: Mean, median, and mode
- Measures of Variation: Range and standard deviation

Appendix B: A Basic Algebra Course Prototype
Beginning Algebra: A Problem-Centered Approach (Safford-Ramus, 1996)

Statistics
- The statistical process
- Random sampling
- Creating and executing a survey
- Organizing data and representing the results using graphs

Functions
- Functions modeled by equations
- Representing functions with tables, graphs, and equations
- Representing problem situations using algebraic expressions
- Finding truth sets of equations
- Evaluating and simplifying algebraic expressions
- Solving equations using legal transformations
- Rational Numbers and Expressions
- Modeling fractions
- Adding and subtracting rational expressions
- Multiplying and dividing rational expressions
- Solving equations and word problems involving fractional expressions
- Operating with decimals
- Ratios and rates
- Proportion
- Percents

Real Number System
- Addition and subtraction of signed numbers
- Multiplication and division of signed numbers
- Mixed operations
- Radical expressions and irrational numbers

Non-linear Functions
- Laws of Exponents
- Negative Exponents
- Operating with polynomials
- Quadratic functional equations
- Systems of equations