Notes

I. Overview
   a. Initial level of algebraic thinking lies in the understanding of patterns and relationships
      i. In the primary grades, children are expected to further their capabilities to recognize, name, build, draw, compare, and sort two- and three-dimensional shapes
      ii. Children should also:
         1. Gain some understanding of symmetry
         2. Be able to create mental images of geometric shapes
         3. Recognize shapes from different perspectives
         4. Relate ideas in geometry to number and measurement
         5. Locate geometric shapes in the environment
      iii. Primary-level children are expected to move further in their understanding of data analysis by being able to describe and explain the meaning of data and make predictions from data
         1. Expectations for understanding probability are at an informal level only
   b. Focal Points for primary grades include an emphasis on integration of several of the topics in this unit
      i. Grade 1
         1. Focal point in geometry is composing and decomposing shapes
         2. Connections include using geometric shapes for informal measurement and on bar graphs, and connecting patterns such as odd and even numbers as a basis for algebra
      ii. Grade 2
         1. Focal Point for second grade number and operations is learning methods of estimation
         2. Connections are made to geometry as children collect data related to space
         3. More knowledge of number patterns is obtained that lead to later algebraic understanding
      iii. Grade 3
         1. Focal point in geometry is describing and analyzing two-dimensional shapes so that an understanding of congruence and symmetry is developed
         2. Multiplication and division and their relationship connect with algebra readiness
         3. Whole number operations are applied when working with data analysis constructing and analyzing frequency tables, bar graphs, picture graphs, and line plots in order to solve problems
   c. Children need a basic understanding of shape and space, which they apply to the early graphing and mapping experiences during the preoperational period, to help them to move on to higher-level graphing and geometry concepts
      i. Children should know the basic characteristics of shape and be able to
identify geometric shapes such as circles, triangles, squares, rectangles, and prisms when they enter the primary level

ii. Should also have the spatial concepts of position, direction, and distance relationships and be able to use space for making patterns and constructions

iii. During the primary years, they should continue with these basic experiences and be guided to more complex levels
d. Geometry is studied in a very general, informal way during the elementary grades
   i. Spatial concepts are reinforced, and the senses are sharpened
   ii. During the primary years, geometric concepts continue to be developed mainly at an intuitive level
   iii. Geometric figures are used to teach other concepts, so children should be familiar with them.
      1. Multiplication is frequently illustrated in a rectangular grid
      2. Fractions are commonly illustrated using geometric shapes
      3. Number lines are conventionally used to help children visualize greater than, less than, betweenness, and the rules of addition and subtraction
e. Collecting and organizing data continue to be important applications of mathematics
   i. Graphing is closely related to geometry in that it makes use of geometric concepts such as line and shape
   ii. Tables are the necessary first step in organizing complex data prior to illustrating it on a graph
   iii. Charts are closely related to graphs
f. In the 21st century we look at algebra as “a way of thinking, a method of seeing and expressing relationships”
   i. Algebra provides a way to organize and generalize the patterns we observe in everyday activities
   ii. Through learning how to develop relationships, we can understand the regularities, not just in mathematics, but also in science, history, economics, language, and so on
   iii. Moses suggests that algebraic thinking can begin in the early primary grades through the use of geometric concepts such as perimeter and involve investigations with square tiles, string, pipe cleaners, and grid paper
      1. Students can identify geometric and number patterns as they explore these relationships
   iv. Technology can also be used to support the development of algebraic thinking.
   v. Algebra has been defined in the NCTM standards and in the navigations publication for prekindergarten through grade two algebra
g. Technology involves applications of a broad base of skills
   i. Design technology is an integration of engineering, mathematics, and science
ii. Another integration is the application of a variety of skills and concepts in the development of robotics projects

II. Assessment
   a. Readiness for primary-level activities should be assessed using the assessment tasks that accompany Units 12 and 13
   b. Readiness is also measured by observing children’s capabilities in accomplishing the graphing activities in Unit 20 and the higher-level graphing and spatial relations (mapping) activities in Unit 25
   c. Not safe to assume that children have had all the prerequisite experiences before they arrive in your primary classroom

III. Activities
   a. Geometry
      i. Primary children are not ready for the technicalities of geometry, but they can be introduced informally to some of the basic concepts
         1. Can learn about points as small dots on paper or on the chalkboard
         2. Curves are introduced as smooth but not straight paths that connect two points during a story or a mapping activity
         3. Lines appear as number lines, in measurement activities, and as the sides of geometric figures
         4. Children perceive angles (space made by the meeting of two straight lines) in geometric figures
         5. Congruency or sameness of size and shape is what children deal with when they match and compare the size and shape of various figures, such as when they sort attribute blocks or make collages from paper shapes
         6. Symmetry (correspondence of parts of a figure on opposite sides of a point, line, or plane) is what children are working with when they do the paper folding suggested in the unit on fractions
         7. The terms point(s), line(s), and curve(s) may be used with young children without going into the technicalities
         8. The terms congruency, symmetry, and angle will be introduced beyond the primary level and are not essential to working with the concepts informally

IV. Technology
   a. Robotics: Lego® and LOGO
      i. LOGO computer language can provide experience with geometry and technology at a number of levels
         1. With just a few simple commands and minimal instruction, children can explore, play, and create an infinite number of geometric shapes and designs
         2. With a little more structured approach, they can learn how to plan out patterns ahead of time and use more complex instructional commands
         3. The cursor, referred to as the turtle in LOGO, can be moved
about in many directions, at different angles, to make straight or curved lines

4. Problem-solving skills are developed when children work on figuring out how they will make the turtle go just where they want it to in order to come up with a particular design or figure

ii. Children’s building with Lego® building bricks and their exploration of LOGO are combined in math/science/technology connection with Lego®/Logo, Lego®Mindstorms, and LEGO Dacta robotics which provides children with the opportunity to explore physics, technology, and mathematics

1. They have a choice of many projects ranging from a simple traffic light assembly to complex constructions such as bridges, playground rides, construction equipment, and vehicles

2. In the original version, the computer was programmed to control the operation of Lego® machines
   a. More recently National Instruments, LEGO Dacta, and Tufts University have developed a ROBOLAB system which enables students to write computer programs and transfer them into programmable Lego® bricks

3. Even kindergartners can create their own robot designs.
   a. Lego® Mindstorms includes many robotics products with sets for building Star Wars robots and many others

4. With the invention of the programmable bricks, the robots no longer need to be bound to the computer

b. Design technology
   i. Primary grade students can follow more structured directions and work on projects individually or in small cooperative groups
      1. Virginia’s Children’s Engineering Council, the Virginia Children’s Engineering Journal, and Children Designing and Engineering provide information and activities that provide problems for design technology

   c. Collecting and analyzing data and constructing graphs
      i. Students can collect data, categorize the results, and depict the results in a graphical representation for analysis
         1. Graphing includes:
            a. Constructing graphs
            b. Reading information on graphs
            c. Interpreting what the information on a graph means
         2. The data used for making graphs need to be something of interest to the students

      ii. Four most popular types of graphs are:
         1. Picture graphs
         2. Bar graphs or histograms
         3. Line graphs
            a. Some primary-level children can begin to work with line graphs
b. Demand concrete operational thinking because more than one aspect of the data must be focused on at the same time
c. Line graphs are made on a squared paper grid and apply the basic skills that children would learn by first doing the squared paper activities with the geoboard
d. Especially good for showing variations such as rainfall, temperature, and hours of daylight

4. Circle or pie graphs
   a. Beyond the primary level
d. Charts and tables
   i. Constructed to organize data before they are graphed
   ii. A simple chart consists of tick marks such as depicted in the chart on floating and sinking objects in Unit 10
       1. This information could be translated into a single variable graph showing frequency of floating or sinking for each object or into a double variable graph showing both
e. Algebraic thinking
   i. Michaele F. Chappell outlines the roots of algebraic thinking in the primary grades
       1. Primary children are not ready for formal algebraic equations such as x + 5 = 8, but they can learn patterns using geometric shapes as variables
       2. When doing missing addend problems, a triangle can be used to represent the missing addend
       3. Counters can also be used to set up the problem
       4. A balance could also be used to demonstrate the problem
   ii. Chappell believes that the gate to algebra can be opened during the elementary years
f. Estimation
   i. Estimation is an important activity at the primary level
       1. As children enter the concrete operations period, they can begin to make rational estimates
g. Probability
   i. According to NCTM, probability is very informal at the primary level
   ii. Suggested that children be challenged to answer questions about what is most likely and what is least likely

V. Integration Across the Content Areas
a. Concepts described in this unit can be applied across the content areas

VI. Ideas for Children with Special Needs
a. Children with Down’s syndrome (DS) also need special attention and accommodations
   i. Tend to be relatively slow in language development due to poor short-term memory especially for auditory material and poor long-term memory for verbal and spatial material
   ii. Need lots of repetition of new skills along with review of previously
learned prior skills

1. Lessons need to be simple and include a minimum number of materials and instructions
2. Range of DS abilities is broad so careful assessment is necessary for appropriate planning
3. Task analysis, breaking tasks into small steps, is a technique used effectively with DS children

VII. Evaluation

a. Note whether children can follow directions and maintain involvement in the activities
   i. Observing the process in these activities is critical
   ii. When children are not able to do an activity, it is important to note where the process breaks down
      1. Does the child have the basic idea but just needs a little more practice and guidance?
      2. Does the activity seem to be beyond the child’s capabilities at this time?
   iii. These activities require advanced cognitive and perceptual motor development, so children should not be pushed beyond their developmental level
   iv. If children work in pairs or small groups of varied ability, the more advanced can assist the less advanced