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Douglas Knudson


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Mathematics in the Forest
by Douglas M. Knudson, Extension Forest Recreation Specialist

Many parks, forests, and schools have woods or fields where youth groups or classes can learn the practical applications of mathematics. In the woods, the principles of arithmetic, geometry, trigonometry, simple statistics, and many other quantitative skills can be practiced. The abstract nature of the classroom is often a barrier to learning math. In the woods, the individual is counting and measuring tangible things, not black marks on paper. Living skills, not just number exercises, are emphasized.

The following ideas give the leader or teacher a start on developing math exercises. They can be adapted to any age or skill level. For instance, high school teachers can use some of the higher mathematics in explaining the exercises. A leader of young children can concentrate on measuring and counting.

- Determine distance by pacing. Each young person can learn how long a stride is by stepping off a course and dividing the distance by the number of steps taken. Measure a course over 100 feet long. Compare paces on hills and on the flat. The pace can then be used for distance measuring activities such as estimating the length of a trail, a creek, or forest boundaries.
- Graphically record the number of occurrences of different phenomena in the woods. For example, how often do trees branch? How many birds are seen on different days? How many different kinds of birds were seen by different people in different parts of the woods? How much rain falls and when? How many different sizes of trees are sampled in an area? Graph them.
- How many leaves are on a tree? Estimate the number of leaves on several branches, and use ratios to estimate the number of leaves on the whole tree.
- Estimate the area of a leaf, using the grid method. From that, estimate the leaf area of a whole tree. This will require a number of measurements of various leaves; each participant can have a different size leaf from the same tree.
- Collect differently shaped leaves on the ground; relate them to geometric figures. Spin-off activities can be developed. For example, by sampling a small area, the number of kinds of leaves can be determined in different months. Then, draw inferences about rates of fall over time and deterioration of leaves on the ground. (Oak leaves generally fall late and stay on the ground longer than others because of their high tannin content. Walnut leaves, however, fall early and deteriorate rapidly.)
- Saw a log in half. Count the rings; how old is the tree? Notice increases in size of the rings from year to year.
- How much volume is in a log? Estimate it for short logs using the formula for a cylinder or for entire trees using the cone formula. Across a cut end, determine the volume of wood added in the past one to five years. Measure the width of the ring(s) and of the entire log diameter; determine the volume added as a ratio problem.
- Find the diameter of a standing tree. Wrap any measuring tape around the tree at 4½ feet above the ground and calculate the diameter \( d = \frac{C}{\pi} \). From this calculation, you can determine the area of the stem or “basal area” \( A = \pi r^2 \). Use tree-measuring calipers for direct diameter measurement.
- Calculate the basal area of all trees on an acre or hectare (10,000 square meters). Set up small 1/5-acre plots (radius of 52.6 feet) or use metric plots. Measure all trees greater than 5 inches in diameter.
at 4½ feet above the ground. Figure the basal area per 1/5-acre plot. Multiply by 5 to convert to square feet of basal area per acre. Samples at various points in the woods will reveal variations in tree stocking. How many 5-inch diameter trees are needed to have a basal area greater than one 20-inch tree?

• Determine the height of a tree. First, collect guesses. Then, measure the height by any of several methods. a.) Measure the tree’s shadow, using proportions of the shadow of a measured, vertical stick. b.) Determine the angle of elevation and use tangent ratio. c.) Stand a person five feet in height by the tree; move back; and then measure the number of five-foot intervals it takes to get to the top of the tree.

• Using graphs, each individual can make a bar graph of heights estimated. Then the group can make a bar graph showing the distribution of tree heights throughout the forest. The same can be done for diameters, basal area, and other factors measured.

• Calculate and measure the slope of a hill; match measurements with the preliminary visual estimates recorded by the individuals. Relate degrees and percent measures of slope.

• Calculate the distance across a creek, lake, or open field where you cannot walk. This calculation can be made by using different triangulation and geometric methods. You can use problems right out of a textbook for this exercise.

• Figure the rate of flow of water in a stream. You can float an orange down a measured stream segment to calculate the rate of flow in meters per second. Multiply this figure by the cross sectional area of the stream, which is water flow in cubic meters per second. The cross section area is determined by multiplying width times the average of several depth measurements across the stream along a single transect. The stream profile can be graphed.

Check math textbooks or workbooks for other examples. Word problems that are complicated in the classroom gain real meaning in the field. A local forester or a surveyor can answer many of your questions. Contact the Cooperative Extension Service or Soil Conservation Service for assistance.

Sources of Teaching Ideas
U.S. Fish and Wildlife Service. (1975) Outdoor classroom, environmental education guides. U.S. Department of the Interior and Minnesota Environmental Sciences Foundation, Inc. (Many different “guides” for different activities, each about 6 pages.)

---. (1975) We can help; a teacher’s guide to environmental education activities. U.S. Department of the Interior and Minnesota Environmental Sciences Foundation, Inc.

Planning a school environment. (1972) This and above publications available from: Minnesota Environmental Sciences Foundation, Inc., 5400 Glenwood Avenue, Golden Valley, MN 55422.


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