Mathematics Education and Technology

Marlow Ediger

Dr. Ediger is professor of education at Northeastern Missouri State University, Kirksville. He was the 1985 recipient of the Project Innovation's Merit Award for Excellence in Teacher Education. He is a regular contributor to delta-K.

Much has been written about using technology to teach mathematics. Such semi-concrete audiovisual aids as slides, films, filmstrips, transparencies and single-concept film loops have been used for several decades, and their use is increasing.

Prior to the advent of semi-concrete materials, mathematics educators advocated using concrete materials in the classroom. Objects and items used to teach stress the concrete. Students learned by relating the real world of objects to abstract ideas in mathematics.

In addition to using semi-concrete materials, the mathematics teacher should emphasize abstract learning. Reading materials and student-teacher interaction help students move from the concrete to the semi-concrete to the abstract.

Computers in the Curriculum

Computers are a relatively recent development in teaching mathematics. The principles of educational psychology should guide the teacher in selecting software for the curriculum. First, the software and computer should provide learning opportunities that are interesting and that secure the student's attention. Time on task is significant. Absent students waste their own time, as well as the time of the teacher. A major concern with technology is whether it attracts and maintains student interest.

Second, software should be meaningful to the learner. Students need to understand sequential content. The subject matter must make sense; if it is too complex, students will not be able to understand it. If it is too easy, students will learn nothing. Software must provide students with realistic goals.

Students need reasons for learning. They should find value in the content of computerized instruction. Although students perceive the content in mathematics to be worthwhile, they frequently fail to find value in the objectives emphasized in software content. Teachers need to evaluate new software to see if it contains striking content and reflects worthwhile objectives. The chosen objectives should guide software selection.

Slow, average and fast learners need to be respected for the abilities they possess and the levels of learning they have attained. The teacher must identify objectives, provide learning opportunities and select appraisal methods that assist each learner to achieve as much as possible. Software that provides for slow, average and fast achievers needs to be made available.

Regardless of abilities, students must achieve cognitive, affective and psychomotor objectives to the best of their abilities. First, cognitive process, which stresses intellectual tasks, is important. Students need to achieve structural ideas, major generalizations and higher-order thinking skills. Second, the affective or attitudinal category must also be emphasized. Students having healthy attitudes will likely enjoy and appreciate mathematics. A third objective is to improve psychomotor functions. Students require good eye-hand coordination, coupled with gross and fine-motor movement to construct models, designs and figures in mathematics.

Students need feedback on ongoing and completed work. Feedback informs the students about their progress, alerts them to what is incorrect and shows them how to remedy identified deficiencies. Computers and software provide students with immediate results

to responses made sequentially. If students do not receive feedback, they may make identical or similar errors. Allowances should be made for trial and error—this learning process teaches students to generalize.

Students should be provided with both deductive and inductive learning opportunities. Teachers should select software that helps students to learn a new process through deduction. Students need opportunities to discover and find out on their own—the thrill and excitement of discovery are extremely valuable.

Students need opportunities to apply what they have learned. Objectives achieved by students using software should reflect the level of application. The applications can be made within the framework of sequential experiences contained in the software program. Applications can also be stressed by using mathematics textbooks, workbooks, worksheets, as well as actual problems in society. Mathematics is dynamic, utilitarian and functional in the day-to-day lives of students.

Selecting Software

Teaching materials should be evaluated before, during and after use; software should be thoroughly and continually evaluated. Which criteria for evaluation should then be applied in teaching-learning situations?

Software must assist students to achieve objectives and should be related to material taught in a lesson or unit. Content in software must relate to preceding subject matter. Unrelated facts, concepts and generalizations might well confuse students. High quality instruction and depth learning by students, rather than survey approaches, should be undertaken. Carefully chosen software directly related to objectives in the curriculum can aid students to understand subject matter in-depth. Depth teaching is not a process adding new content to previous subject matter. Rather, depth teaching forces students to relate the new ideas gained from using computers to their previously acquired learning. Depth learning focuses on helping students to grasp structural ideas and major generalizations more fully and comprehensively. Attitudes toward learning mathematics should become more positive as students attach increased meaning to acquired subject matter.

Software must present the content sequentially so that students perceive order and structure. Students in the classroom need to experience success, not failure. Properly sequenced software ensures that students have success and provides a foundation on which new subject matter can be learned. Therefore, writers of mathematics programs must test and develop sequence.

Software content should promote successful learning. Success reinforces what students have learned, and subject matter, in turn, is learned more effectively with reinforcement. Everyone desires to be successful in life—students are no exception.

As with sequence testing, the success rate of the program needs to be field-tested adequately. If the steps involved in learning are spaced too far apart, then the programmer should add items to the program so that students can respond correctly more frequently.

Students should be given the opportunity to respond frequently to questions and multiple-choice items within a program. Often, required reading leaves the student with very little responding time in a software program. Frequent interactions are recommended so the students receive feedback to their responses.

Drill and practice are necessary activities. Carefully selected software should guide students to review what was learned previously. If drill and practice are not stressed, students tend to forget the subject matter. Retaining information is important in mathematics.

Other software deals with games and gaming. In a game situation, two to four students can be involved in wholesome competition. Each student tries to gain as many points as possible by answering mathematics questions on the monitor. The student with the most points wins. Easier questions are worth fewer points than are more complex ones.

A fourth type of software covers simulations in which students play roles in solving real problems. Compared with day-to-day situations in school or home, simulations provide low-risk situations for students. Higher levels of thinking must be stressed in simulated programs.

Diagnostic and remedial programs may be employed in the mathematics curriculum. Diagnosis pinpoints specific difficulties that a student has in mathematics. Based on diagnosis, remedial programs follow.

Along with software related to ongoing lessons and units in mathematics, additional learning activities and resources must be available to students. These resources include textbooks, workbooks, filmstrips, slides, films, transparencies, overhead projectors, illustrations, videocassette tapes and single-concept film loops.

To help students, mathematics teachers must follow recommended principles of learning. These principles stress ways of guiding learners to attain as much as possible. They are applicable regardless of the aids used to teach mathematics. Aids include computers as well as textbooks and audiovisuals. Teachers should employ drill and practice, tutorials, games, simulations, and diagnosis and remedial techniques. Ultimately, each student's goal should be to achieve as much as possible in mathematics.