Philosophy, Computers and Mathematics

Marlow Ediger

The mathematics curriculum ought to emphasize the use of computers. Software packages should guide learners to achieve objectives, stressing the acquisition of subject matter in sequence so that students can make the best possible progress. Sequential learning relates new subject matter to that previously acquired, and knowledge that is related is retained longer by students than fragmented knowledge. Thus, good software in mathematics should provide content that is correlated and integrated with subject matter previously studied.

Software content that captures students' interest and attention and permits the establishment of sets will motivate students to achieve appropriate objectives in mathematics. Students also need to understand the purpose of achieving vital facts, concepts and generalizations in mathematics, and mathematics teachers should encourage students, inductively or deductively, to accept reasons for learning. Once they have understood the purpose, students must become actively involved in comprehending vital subject matter presented by the software.

Philosophy of Using Software in Mathematics Education

The mathematics teacher needs to study and analyze diverse schools of thought on the subject of computer software curriculum. Each philosophy makes its own recommendations for teaching-learning situations so the philosophy chosen should fit the personal learning style of the student.

The Problem-Solving Strategy

To implement a problem-solving strategy in lessons and units, the first step is to identify the mathematical problem carefully. This problem should be selected by students with the guidance of the teacher in a contextual situation. Each problem should have to do with real life and society, making clear the societal relevance of the mathematics curriculum to the student.

The next step requires gathering information to solve the problem, some of which may be obtained from relevant software, as well as other reference sources such as mathematics textbooks and workbooks, and audiovisual materials. A hypothesis, tentative and subject to modification as a result of testing, is then generated to help answer the problem.

Problem-solving strategies in mathematics do not

- have predetermined objectives for student attainment;
- possess a logical sequence in which the mathematics teacher/educator selects sequential learning activities for students;
- emphasize a behavioral model of teaching. Behaviorism stresses objective, measurable results in each step of student learning;
- advocate paper-and-pencil tests of student achievement, but rather measure it in terms of ability to define and solve real problems in mathematics;
- stress a highly structured sequence in the curriculum. Problem solving emphasizes openness, creativity and flexibility in problem identification, information gathering, hypothesizing and testing, and revising the hypothesis.

Good software should assist with information gathering and testing hypotheses.

On problem solving, Grossnickle et al. (1983, 177) write:

> Problem solving is a process by which the choice of an appropriate strategy enables a pupil to proceed from what is given in a problem to its solution. Often the answer is the least important part of the problem-solving process; few of the answers

children obtain in school mathematics will have much value in their lives. The ideas used in the process are much more valuable than the answer. Thus it is important for teachers to determine whether an incorrect answer is due to an error in process or in computation. Do not, however, infer from this discussion that errors in computation are acceptable; rather, keep in mind that overemphasis on answers may impede the pupil's understanding of the process. A pupil with poor computational ability who understands the process can use a calculator to get the answer. A pupil who can compute rapidly and accurately but does not understand the process is lost.

The Decision-Making Strategy

A second school of philosophical thought concerns the decision-making strategy. Here, the student selects learning activities from among alternatives. In mathematics, an adequate number of software packages are available for students to choose from, and they select those that have purpose, meaning and interest. Besides software programs, activities with textbooks, workbooks and audiovisual materials are available.

This strategy may be implemented using a learning centres approach. With this method, each learning centre is equipped with software related directly to the mathematics unit being taught. The content appearing on the monitor guides the student interactively until vital objectives are mastered. Students may choose their own objectives—preferably, the most challenging ones—and the kinds of software by which these objectives can be attained.

A contract system may also be useful in a decision-making strategy. With the teacher's guidance, the student selects the computer programs and writes them up in contract form with a specified due date, and the student and teacher both sign it. The student then selects the sequence of programs to complete. Further, the student may select objectives to achieve, with student and teacher cooperating to determine the learning opportunities and the computer or other activities to be undertaken. Appraisal procedures are also cooperatively developed.

Decision-making strategies do not emphasize

- a predetermined mathematics curriculum. Instead, students must invest time and effort into selecting their learning objectives and opportunities and their appraisal procedures within the framework of the mathematics software/computer curriculum;
- a subject-centred curriculum only. It is equally important to emphasize attitudes and the affective dimension when using computer software in the mathematics curriculum;
- an essential or basic curriculum for all students. Rather, students choose among alternatives what software activities and experiences they will pursue;
- a logical curriculum whereby the mathematics teacher or objectives set by the government determine the sequence of what students are to learn. The students determine themselves what they are to learn as part of a "psychological curriculum";
- a formal mathematics curriculum. Instead, the students' ability to choose what software they will use makes for flexibility and open-endedness.

Abelson (1982, ix) writes on students' use of Logo:

> Logo is the name for a philosophy of education and for a continually evolving family of computer languages that aid its realization. Its learning environments articulate the principle that giving people personal control over powerful computational resources can enable them to establish intimate contact with profound ideas from science, from mathematics, and from the art of intellectual model building. Its computer languages are designed to transform computers into flexible tools to aid in learning, in playing, and in exploring.
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> We try to make it possible for even young children to control the computer in self-directed ways, even at their very first exposure to Logo. At the same time, we believe Logo should be a general-purpose programming system of considerable power and wealth of expression. . . . More than 10 years of experience at MIT and elsewhere have demonstrated that people across the whole range of "mathematical aptitude" enjoy using Logo to create original and sophisticated programs. Logo has been successfully and productively used by preschool, elementary, junior high, senior high, and college students, and by their instructors.

Measurement-Driven Instruction (MDI)

This third philosophy of instruction requires predetermined objectives of student attainment to be stated in precise, measurable terms before computers are used. The objectives may be mandated by the government, the school district, or the mathematics teacher. Good-quality software programs provide the subject matter in the appropriate sequence students need to attain the objectives. To ensure validity of content, appraisal procedures should also accord with the objectives. Reliability in measurement procedures must be established, using test-retest, split-half or alternate forms.

A carefully constructed sequence of objectives, learning opportunities involving computer software use, and appraisal procedures is required. Each of these components is related to the others. Thus, designing the curriculum with a measurement-driven instruction model might help students succeed better in the computer software mathematics curriculum.

Measurement-driven instruction does not emphasize

- an open-ended mathematics curriculum whereby students choose their own software programs;
- a psychological sequence in which students direct their own learning experiences. Instead, mathematics educators select the objectives, activities and appraisal procedures;
- decision-making by the students as to the scope and sequence of the curriculum;
- problem-solving activities that relate society to school mathematics within the computer software curriculum;
- general objectives in mathematics.

Instead, precise, measurably-stated ends are emphasized.

Conclusion

In summary, software programs in mathematics might emphasize

- problem-solving strategies. Real-life problems in mathematics need to be identified and solved;
- decision-making strategies. Students can select from among alternative objectives, learning activities and appraisal procedures;
- measurement-driven instruction. With precise, predetermined objectives, students are clearly seen to achieve or fail to achieve these ends.

However, I recommend that emphasis continue to be placed on problem solving. In the real world, personal and social problems exist that need solution, and people need to be able to solve them.

Software programs in mathematics can emphasize

- drill and practice—to help review what students have learned;
- tutorials—to guide students in acquiring new content in sequence;
- simulations—in which students play roles to solve problems;
- games—in which students individually or in small groups compete against others in an atmosphere of respect and appreciation.

These four kinds of software should help students learn in the mathematics curriculum.

References

Abelson, H. *Logo for the Apple II.* Peterborough, N.H.: BYTE Books/McGraw Hill, 1982.

Grossnickle, F.E., J. Reckzeh, L.M. Perry and N.S. Ganoe. *Discovering Meanings in Elementary School Mathematics.* 7th ed. Chicago, Ill.: Holt, Rinehart and Winston, 1983.