DOCUMENT RESUME

ED 458 113 SE 065 253

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TITLE Developing the Mathematics Curriculum.
PUB DATE 2001-10-00
NOTE 11p.
PUB TYPE Opinion Papers (120)
EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS Academic Achievement; Elementary Secondary Education; *Knowledge Base for Teaching; *Mathematics Curriculum; Mathematics Instruction; *Mathematics Teachers; Portfolio Assessment; Standardized Tests

ABSTRACT

This essay, written for mathematics educators, addresses a series of questions related to the development of curriculum in mathematics education. The case is made that mathematics curriculum must be evaluated continuously to stay abreast of recent research results and needed trends. Also addressed is the question of how much mathematics instruction students should have. The advantages and limitations of standardized tests are discussed, and the case is made for portfolios as an effective way of recording student achievement. The final topic of discussion is the importance of philosophies of teaching and learning for practice. (Contains 10 references.) (MM)

Developing the Mathematics Curriculum

by Marlow Ediger

DEVELOPING THE MATHEMATICS CURRICULUM

The mathematics curriculum must be evaluated continuously to stay abreast of recent research results and needed trends. Teaching and learning in mathematics does not stay the same but is subject to modification and change. The psychology of teaching and learning is one area, among others, which is changing and needs to emphasize change in teaching mathematics to students. The following are important to stress in the classroom:

1. learnings need to be interesting to capture student attention in achieving mathematics objectives of instruction. If students lack interest, the chances are that little effort is put forth by the learner to grow, accomplish, and achieve. Student interest in learning makes for effort to achieve new heights in mathematics.
2. learnings ned to stress purposeful experiences for students. With purpose, the student sees reasons for attaining vital goals in the mathematics curriculum. If purpose is not involved, the chances are a low energy level for achieving will come into being. Each student needs to learn as much as possible in mathematics.
3. learnings provided for students need to make leeway for individual differences. Students have unique learning styles and reveal content learned in a plethora of ways. Students are unique individually from others and individual differences need adequate provision.
4. learnings opportunities to achieve objectives should involve active engagement by students. Concrete, semi-concrete, and abstract experiences then need to be in the offing. Students learn mathematics with the use of diverse kinds of activities.
5. learning opportunities need to challenge students to do their very best to achieve optimally. Being satisfied with mediocre or modest achievement is not adequate. Rather, optimal achievement is desired and needs to be expected. Reasonable and high expectations for all students are musts!
6. learnings need to be meaningful. Thus, each student needs to understand that which was presented in ongoing lessons and units of study. Understanding is different from rote learning and memorization. With understanding, the student can explain facts, concepts, and generalizations in his/he very own words.
7. learnings acquired in mathematics should be useful. A student then can apply what has been learned. New knowledge

acquired should be applied so that retention of subject matter can be maximized. Students forgetting what had been learned makes for lost time in the mathematics curriculum. Retention and use are key concepts to stress in teaching students.

8. learning activities provided should emphasize student success in goal attainment. Success for students, not failure, is vital in teaching and learning situations. With success, good self concepts are developed. An adequate self concept is important in order to achieve optimally in mathematics.

9. learning opportunities should provide situations whereby a student may be recognized for achievement. Students individually desire to be identified within a group for doing well. Each student may then receive praise for doing better than previously in ongoing lessons and units of study in mathematics.

10. learning opportunities need to be sequenced properly so that the new content to be acquired is built upon what was learned previously. Background information achieved provides that which is necessary to attain the new subject matter (Ediger, 2000, Chapter Seven).

It is then imperative for teachers to use tenets from the psychology of learning in order that students individually achieve as much as possible in mathematics.

How Much Mathematics Instruction Should Students Have?

There is concern over the strong emphasis on reading instruction which might then minimize numeracy development on the part of students. The National Council Teachers of Mathematics (NCTM) and the National Association for the Education of Young Children (NAEYC) drafted a joint resolution pertaining to appropriate mathematics instruction for 3 to 6 year olds:

"this originated from concerns that we need to send a message about the importance of high quality mathematics experiences"... The position statement is the latest in a series of activities over the past few years that has brought early childhood education and experts in math education together.

In 1998, the American Association for the Advancement of Science held a conference for early childhood educators and researchers to talk about math and science for preschoolers. With grant money, a document was developed entitled "Engaging Young Children in Mathematics" which contained a description of

high quality mathematics experiences for young children and types of materials and activities that teachers can use to develop children's awareness of such concepts as numbers and geometric shapes. In the other section of recommendations, the authors will explain what it takes to equip early childhood teachers with the knowledge and skills to strengthen their teaching of math. Simply taking more mathematics courses in college is not the answer...(Jacobson, September 6, 2001).

With state mandated standards and testing, there is an increasing emphasis being placed on students achieving at a higher and higher level. To achieve state mandated standards for any grade level, students need to start school at an earlier age, such as preschool. Achievement is measured either through the use of state developed or through standardized tests. State developed tests are more likely to measure what was taught in the classroom, as compared to standardized tests, if the state standards (objectives of instruction) were followed carefully by teachers in teaching and learning situations. Thus, there is increased validity in testing. Additional standards which need to be followed in developing state mandated tests are the following:

1. these tests have been pilot tested to take out vagueness within test items. For example, word problems need to be clearly written so that each student understands the content and knows what is wanted when responding. Printouts from responses of students to test items provide data for the examiners to evaluate the quality of each test item.
2. test results, from pilot studies, should indicate if the test is written at too easy or too complex a level of achievement . If 90 % fail the test, then it is written at too complex a level. Or, if 99 % pass the test, then the test is written at too easy a level to truly measure learner achievement. It is not possible to locate and describe absolute standards for students to achieve (See Education Week, April 18, 2001).
3. test results should provide feedback to the teacher in terms of what needs to be taught to remedy deficiencies of each student.

Standardized tests have the following weaknesses to measure student achievement:

1. they tend not to measure in a precise manner what was taught in the local classroom. Why? The tests are not aligned with any set of available objectives. They are global in nature and measure what probably could have been taught nationally in

classrooms.

2. they are standardized in that students taking the test are given the same amount of testing time, the same directions for test taking, as well as the same test items. There is no provision made for individual differences in that selected students need more time as compared to others in completing school tasks as well as completing a test or portion thereof. Then too, selected students cannot compete with others when the same test items pertain to all taking the test. Thus, achievement levels differ when comparing one student with the next.

Test results provide numerals to show achievement. This numeral is generally a percentile. A single numeral will not tell much about a student's achievement in mathematics. Additional means ned to be used to show progress of learners. A single numeral omits completely what students have learned in mathematics in the daily classroom. To incorporate what students have accomplished in the classroom, a portfolio may be added to the evaluative process to indicate student progress. The portfolio may possess the following:

1. daily papers of student work from mathematics assignments. By looking at daily student work in mathematics, the viewer can notice specifics in terms of remediation work which needs to be done.

2. cassette recordings of committee work of learners. The cassette may reveal the quality of interactions among learners and the knowledge and skills achieved in mathematics.

3. a video-tape showing the student being involved in cooperative learning. Here, viewers of the portfolio may notice the quality of thinking skills and basic ideas achieved.

4. art products revealing mathematics achievement. Multiple intelligences theory of learning indicates there are a plethora of ways for students to reveal what has be achieved in mathematics (See Gardner, 1993).

5. construction items made to indicate progress in mathematics. Making place value charts and fraction charts are examples of what students may construct and use to achieve meaning in mathematics. Snapshots of large items need to become a part of the ensuing portfolio

6. written library book reports on mathematics. There are good fiction and nonfiction library books written for grade school students.

7. diary and log entries kept on concepts and generalizations acquired. The diary entrees incorporate what a student learned in mathematics on a daily basis whereas the

logs summarize the diary entries to draw conclusions.

8. journal writing on personal impressions from ongoing mathematics lessons and units of study. Journal writing is quite open ended in that a student may write about feelings incurred, knowledge gained, as well as skills acquired,

9. accomplishments from working in peer learning situations. Learning with peers emphasizes learning styles theory (See Searson and Dunn, 2001). There are students who work together well in achieving as compared to working by the self. Other students may achieve more optimally by working individually on activities and projects.

10. entries on dramatizations made on certain facts and main ideas gained. Dramatizations can be a good way to emphasize selected learnings like individuals involved in making set of three and a set of four. The two sets may be joined together to show that 3 + 4 = 7 (See Ediger, 1996).

Portfolios are developed by students with teacher guidance to emphasize what a student has learned in the classroom. Standards for portfolio development include the following:

1. a random sampling of products need to be incorporated. The portfolio should not become too bulky since it needs to be evaluated by at least two appraisers. Careful attention then needs to be given to what goes into the portfolio.

2. the portfolio should indicate improvement from earlier to later performance of the learner. Written work may then be compared to notice improvement in writing from previous attempts.

3. viewers such as parents can notice achievement of their offspring.

4. portfolios may be used for diagnostic and remedial work. Learner achievement should improve when weaknessess in mathematics are remedied.

5. a well developed rubric may be used to ascertain student achievement of items contained in the portfolio (Ediger, 2000, 38-44).

Portfolios can provide an excellent example of reporting student achievement to others. The items contained therein are actual and observable to others. The contents evaluated go much beyond a single numeral such as is given for student test results. They are much more difficult to score since it is time consuming to score the entries within each portfolio. Tests may be machine scored in very large numbers and this can be done quickly. Printouts provide numerical feedback for each test item

of student responses.

Philosophy of Mathematics Instruction

Mathematics teachers need to be familiar with the philosophy of teaching and learning. A philosophy of instruction provides guidance and direction for the teacher to implement quality instruction. Basically, there are two philosophies which are very important for teachers to know thoroughly.

The first, behaviorism which emphasizes realism as a philosophy of education. Realists believe that the real world can be known as it truly is in whole or in part. They believe it can be described mathematically and scientifically with its many specifics. Behaviorism is used in teaching terminology to describe prior to instruction what students should learn and be able to do with its precise objectives. These objectives are generally developed on the state level by the department of education. High standards and high expectations are the present trends of instruction. These state standards, generally described in measurable terms, indicate what students are to learn/do and are available to mathematics teachers. Mathematics teachers need to study and implement these objectives in instruction. Why? The related state mandated tests should cover what is stated in these objectives. Validity might then be in evidence if the tests truly cover subject matter taught in the classroom. All state mandated tests should be pilot rested to take out the weaknesses and also to determine reliability be it test/retest, alternative forms, and/or split half (Reddy, 2001, 506- 510).

From test results, each student then is provided with a percentile to indicate achievement. Precision and measurability describe the world of mathematics and science when stressing realism as philosophy of teaching and learning.

Computerized instruction also stresses precision in the teaching of mathematics with its measurably stated objectives and learning opportunities in textbook form or software versions. Software versions generally emphasize tutorial, drill and practice, simulation, and games (See Ediger, 1998, 62-71).

The second philosophy of education, necessary for mathematics teachers to know and use is experimentalism. Experimentalism is well expressed by its leading advocate John Dewey (1916). The heart of experimentalism is that human beings cannot know the real world as it exists but can know experiences only. With experiences, there are problems which are encountered. Human beings continuously face problems in life and these need to be solved for life to continue. In school

mathematics, students need to experience fife like situations whereby answers are needed. Word problems in textbooks may not represent daily mathematics problems experienced by learners. School and society are to be one and not separate entities, according to experimentalists. People live in society and here is where problems need solutions. Whatever is a life like problem to a student might well then become problems for solution in the classroom. Thus, if a student asks about the present day temperature reading and wants to know how many degrees lower it is than yesterday, the learner needs to be aided in finding the difference between the two, such as 75 minus 48 degrees, for example. Or, a student has $6.25 and needs to have $22.98 to buy a new baseball glove, how much more money does the student need? The teacher may structure the classroom environment with mathematics problems which are daily encounters which need solutions. For example, good teachers have developed a miniature supermarket which resembles one in society. The miniature supermarket exemplifies, to the best possible, what is in the societal arena. Students and the teacher may bring empty food containers to class. Prices may be attached to each container, according to the developmental level of the involved learners. Toy money may then be used for students to "go shopping" for food items involving the containers brought from home. The following pointers are salient for the mathematics teacher to remember when implementing experimentalism as a philosophy of teaching and learning:

1. there needs to be input from students in developing the curriculum. Students then have problems which need solution involving mathematics. Time needs to be given in finding answers.
2. the classroom environment needs to be arranged so that what exists in society may be implemented in terms of becoming a part of the mathematics curriculum.
3. the mathematics curriculum needs to be made as life like as possible, relating the learning opportunities to the personal experiences and interests of students. Interest in learning makes for effort to achieve. The student then does not become separated from the mathematics curriculum but becomes wholeheartedly involved with teaching and learning.
4. the student with teacher guidance needs to
   a) choose a life like problem involving mathematics which has personal value.
   b) gather information from a variety of sources in answer to the problem.
   c) develop an hypothesis form the accumulated

information.

d) test the hypothesis in a life like situation, not through a paper pencil test.

e) modify and revise the hypothesis if necessary.

5. emphasize a student centered sequence as much as possible whereby the learner orders his/her own experiences. This can be compared with a logical mathematics curriculum in which the teacher sequences learning opportunities for students.

6. content taught from basal textbooks should be related to mathematics experiences in every day life. The teacher needs to make content life like for students as would be experienced in society. The school mathematics curriculum is then not separated from what transpires in the real world.

7. thought, deliberation, and reflection are needed when implementing the mathematics curriculum. This is especially true of problem solving experiences.

8. purpose in learning is salient in that the learner needs to perceive the values of learning what is life like in the school/ societal mathematics curriculum.

9. meaning theory needs to be inherent in mathematics. What is meaningful to students then is important, not rote learning and memorization. Understanding of subject matter is vital in the mathematics curriculum.

10. the attitudinal dimension cannot be separated from knowledge and skills used in problem solving (Ediger, 1999, 5-9).

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