Psychology in Teaching Mathematics

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Numerous reputable psychologies are provided to assist mathematics teachers in guiding students to achieve optimally. The teacher of mathematics should study the diverse psychologies of education to implement the best teaching strategy possible. The lay public focuses on student achievement in the three Rs or the basics. Mathematics represents a highly salient basic. Students need to do well in mathematics to do well in school and in society. Teachers need to select objectives, learning opportunities and appraisal procedures that assist learners to achieve as well as is possible.

Behaviorism in the Mathematics Curriculum

Precise, measurably stated objectives and their use is the heart of behaviorism. Objectives are selected prior to being implemented in the classroom. Generally, no student participation has been emphasized in selecting these goals. Behaviorism can be emphasized with state mandated objectives in terms of core competencies and key skills. At the state level, precise measurably stated objectives have been chosen. The department of education of each state selects a cross section of educators to agree upon the stated ends. The mathematics teacher then plans learning opportunities to help students attain each objective.

A second example of behaviorism emphasizes instructional management systems (IMS) at the district level. The central office selects a cross section of teachers within the district to select salient objectives in mathematics. Again, the classroom teacher must emphasize each objective in teaching-learning situations.

The mathematics teacher, without stated mandated objectives or IMS, may write and implement specific ends for student attainment.

An early pioneer in measurably stated objectives and their use was B.F. Skinner. Dr. Skinner emphasized programmed learning in either textbook or software form. The ingredients of programmed learning include

1. sequential items of small amounts of information acquired by students in each step of learning;
2. students responding to a test item, such as a multiple-choice question based on information presented in book or software form;
3. learners receiving feedback based on the response made;
4. reinforcement being rather common with high frequency of correct responses made.

Behaviorism, in its diverse manifestations, emphasizes that a student either does or does not achieve an objective as a result of instruction. If an objective is not attained, the mathematics teacher needs to try a different teaching strategy.

Behaviorism appears to be a dominant psychology of education emphasized in the teaching of mathematics. With the popularity of behaviorism, the writer recommends

1. that each objective in mathematics be carefully selected in terms of being useful in school as well as in society;
2. that students achieve success in attaining sequential objectives;
3. that a variety of challenging learning opportunities be provided for learners to attain each end;

4. that students experience meaning, interest and purpose in achieving desired ends;
5. that critical and creative thinking, as well as problem solving, receive ample attention in the mathematics curriculum;
6. that appraisal procedures be varied, valid and reliable to evaluate learner progress.

Humanism in the Math Curriculum

Humanism, as a psychology of learning, emphasizes students being heavily involved in determining objectives, learning opportunities and evaluation procedures. Each student is guided to attain self-realization. The late A.H. Maslow (1954), humanist psychologist, listed five sequential levels where individuals need assistance to achieve realization of self:

1. assisting students to meet physiological needs, such as adequate food, clothing and proper shelter;
2. helping learners to feel safe and secure in their environment;
3. guiding students in meeting love and belonging needs;
4. developing situations in which esteem needs of students are being met;
5. assisting learners to achieve self-actualization.

Only after the above sequential needs of students have been met can students achieve optimally, according to humanism as a psychology of learning. Meeting the needs of students to increase achievement behooves any school system.

Input from learners in selecting objectives, learning opportunities and appraisal procedures is highly important. There are several excellent ways of emphasizing humanism in the mathematics curriculum. One plan is to utilize learning centres. More tasks than any one student can complete would be at the diverse centres. Students learn to make decisions. They choose, sequentially, which tasks to complete and which to omit. Each learner then selects what is perceived to be of interest, meaning and purpose. Sequence in selecting ordered tasks resides within the student. A psychological curriculum is then evident. Internally, the student makes choices in terms of tasks to pursue.

A second plan of humanism as a psychology of education is to use a contract system. In a contract, the students and their teachers together plan specific learning opportunities for the former to complete. There must be considerable input from the students in the contract for humanistic psychology to be evident. The due date of the contract is indicated with the students' and the teachers' signatures.

A third plan of humanism is when the teacher lists, for example, 10 activities for students to consider to complete in mathematics. Each student may choose 5 or more to complete. The student here has input as to what to pursue and what to omit.

Humanism emphasizes a humane mathematics curriculum. Humanness is defined as students being able to decide from among alternatives which learning activities have value and need to be completed satisfactorily.

The writer, in evaluating humanism in teaching mathematics, recommends that

1. worthwhile tasks be developed for students to pursue sequentially (trivia is to be omitted for learners to pursue);
2. students be guided to stay on task and not digress from achieving relevant objectives;
3. tasks be written on diverse levels of achievement to challenge each student to achieve as much as possible.

The Structure of Knowledge

During the 1960s and early 1970s, much emphasis was placed upon mathematicians on the higher education level identifying structural ideas for public school students to attain. The structure of knowledge emphasized underlying principles that provided a framework for an academic discipline. Thus, in the academic discipline of mathematics, selected broad generalizations provided a structure for students in ongoing lessons and units. The key ideas included the commutative property of addition and multiplication, the distributive property of multiplication over addition, the property of closure and the identity elements.

The structure of knowledge approach, as identified by Jerome Bruner of Harvard University and his associates (1960), emphasized that public school students utilize methods of learning used by mathematicians on the higher education level. An inductive procedure is then evident. Students are guided by the teacher to learn by discovery in moving from the specific to the general to achieve structural ideas. Materials to use in teaching students to acquire content inductively include inactive (manipulative items), iconic (pictures, drawings, slides and filmstrips emphasizing main ideas) and symbolic (abstract content such as printed words and numerals).

The structure of knowledge approach has much to recommend itself. The writer recommends that

1. teachers emphasize structural ideas in a spiral curriculum. However, the spiral curriculum should not be excessively repetitious. The structure has a built-in review when these key generalizations receive attention at more complex levels in mathematics curriculum;
2. induction receive adequate attention in teaching-learning situations. However, continued use of inductive methods is time-consuming. The mathematics teacher needs to inject meaningful explanations also at definite points in ongoing lessons and units;
3. creative teaching in using diverse methodologies be emphasized thoroughly. Methods and subject matter have to be adjusted to the present achievement level of each student as students differ in interests, purposes and present levels of achievement.

Diagnosis in Mathematics

Mathematics teachers must utilize the concept of diagnosis in teaching-learning situations. To diagnose means to pinpoint specific difficulties students experience in computation, concept development and problem solving. Students need assistance to overcome errors made.

Robert Gagné (1985) advocates a hierarchy of objectives be stated in measurable terms for student attainment. If a learner cannot achieve a specific end, the teacher needs to move to an easier sequential objective. Reversing to easier ends is necessary until the student's present attainment level is found. The last three levels of Gagné's hierarchy are especially important to know when teachers diagnose difficulties students experience in mathematics. The three in sequence are concept learning, rule learning and problem solving. Thus, if students cannot solve a problem in mathematics, the teachers need to assist the former to determine if they understand the involved rules. For example, if the problem involves finding the volume of a cylinder, the students must understand the involved formula: $r^2\pi h$. If the learners do not understand the rule to determine the volume of a cylinder, they need assistance in attaching meaning to concepts. The separate concepts are radius, radius times radius, pi and height.

Diagnosis is involved when the mathematics teacher assists the student to pinpoint specific weaknesses in a lesson or unit. Gagné provides a quality model for mathematics teachers to follow in helping learners to progress sequentially.

In using diagnostic-remediation procedures in the teaching of mathematics, the writer recommends that

1. students attach meaning to each sequential step of learning;
2. learners be assisted to perceive holism and sequence in the subject matter learned. Diagnosis is available if a student fails to attach meaning to ongoing rules (generalizations) and concepts to solve problems in mathematics.

Conclusion

Relevant principles of learning from the psychology of education need to be implemented in teaching-learning situations. The teacher of mathematics must assist each student to attain in an optimal manner.

Four schools of thought were discussed in the psychology of education: behaviorism, humanism, the structure of knowledge and diagnosis based on a hierarchy of objectives.

The writer recommends that teachers of mathematics

1. implement tenets of behaviorism with its measurably stated objectives. Higher levels of cognition must not be hindered with the use of behaviorism in teaching-learning situations;
2. provide ample opportunities for students to engage in decision making. Learners need to have chances to select sequential learning opportunities as advocated by humanism;
3. stress the structure of knowledge so that students may perceive that subject matter is related;
4. adequately diagnose and remediate students' problems in lessons and units. Students need to perceive mathematics as being holistic and not isolated specifics in diagnostic/remediation situations.

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