Providing for Individual Differences and The Mathematics Curriculum

by *Dr. Marlow Ediger*
Professor of Education
Northeast Missouri State University
Kirksville, Missouri

Educators have long experimented with numerous means to provide for individual differences in learners. Among other methods, the following have been utilized: contracts, sequential specific objectives, learning centers, programmed materials, packaged materials, computer-assisted instruction, individualized reading and the project method.

Teachers, principals, and supervisors also need to study, analyze, and utilize recommended principles and theories from the psychology of learning. Thus, pupils may be guided to achieve optimal development in the mathematics curriculum, as well as in other curricular areas.

A Hierarchy of Objectives

Robert Gagné, educational psychologist from Florida State University, emphasizes the importance of *educators* in the school-class setting determining what pupils are to learn. The initial question that teachers then need to raise and answer in any unit of study is, "What do I want pupils to learn?" The answer to the stated question becomes a vital goal for pupils to achieve. In order to attain this objective, the teacher must analyze and state specific objectives learners need to achieve sequentially. For example, a teacher may have selected the following goal, among others, for learner achievement:

> Given the number of times a batter hits safely compared to the number of times at bat, the pupil will compute correctly batting averages of five baseball players.

To attain the measurably stated end, the teacher needs to analyze which sequential specific ends pupils need to achieve. These sequential objectives may involve understanding a $\frac{\text{numerator}}{\text{denominator}}$ ratio concept such as $\frac{\text{the number of times hit safely}}{\text{the number of times at bat}}$.

Pupils may also need to achieve computation skills in dividing the numerator by the denominator. Perhaps learners need to achieve skills pertaining to checking their computations. Thus, the teacher needs to determine present achievement levels of pupils and arrange objectives sequentially to guide learners to compute accurately batting averages of selected baseball players. Achieving specific objectives sequentially in a *logical curriculum* may assist each pupil to develop optimally in the mathematics arena.

Jean Piaget and Stages of Pupil Development

Jean Piaget, clinical psychologist from Geneva, Switzerland, in studying pupil development for over 50 years, emphasizes that pupils generally progress through specific stages as a result of maturation.

Piaget has identified the following general stages of individual development:

1. Sensory-motor intelligence (this stage includes, approximately, the first 18 months of an infant's life).
2. Preoperational stage (from age 18 months to seven years, approximately). Pupils in this stage of development lack the ability to think logically. They perceive one variable only, such as the length of an object, or the width of an item.
3. Stage of concrete operations (age seven through age 11, approximately). Learners can think logically; the continued use of concrete materials in teaching and learning is important.
4. Stage of formal operations (age 12 and continuing). Pupils need less of concrete experiences and benefit increasingly more from abstract experiences.

Readiness for moving sequentially through each of the above named stages of development basically cannot be hastened. Thus, biological maturation on the part of each learner is necessary in progressing from the sensory-motor stage of development to the preoperational stage, and ultimately achieving the stage of formal operations.

According to Piaget's school of thought in the psychology of learning, the teacher needs to follow criteria, such as the following, in ongoing units of study:

1. Learning activities must be chosen based on the individual pupil's present level of maturation.
2. Rather heavy emphasis must be placed upon the utilization of concrete materials in teaching-learning situations through the stage of concrete operations.
3. Objectives emphasizing the abstract may be emphasized increasingly so, beginning with the stage of formal operations.
4. The learner must actively operate mentally in ongoing activities and experiences, otherwise learning generally does not take place.

The Structure of Knowledge

Jerome Bruner, psychologist from Harvard University, emphasizes the importance of utilizing enactive (manipulative materials), iconic (semi-concrete experiences including pupils obtaining mental images of concepts), and symbolic (abstract) materials in teaching-learning situations. Thus, within each learning activity, enactive, iconic, and abstract content would be stressed in ongoing units of study. No specific levels of maturation that pupils progress through are emphasized by Jerome Bruner. Thus, readiness for learning may be hastened within each pupil if proper materials and methods are utilized in teaching-learning situations. Jerome Bruner, in the well known book *The Process of Education*, states the following hypothesis: We begin with the hypothesis that any subject can be taught effectively in some intellectually honest form to any child at any stage of development (page 33).

Thus, pupils may achieve complex structural concepts such as the commutative property of addition and multiplication, as well as the associative property of multiplication and addition at a relatively young age in the mathematics curriculum. Pupils may

achieve these structural ideas on each achievement level but at increasing levels of complexity. Jerome Bruner places heavy emphasis upon pupils learning content inductively. Thus, the stage needs to be set for pupils to achieve structural ideas through induction. Excitement in learning occurs if pupils find out on their own rather than hearing explanations to acquire facts, concepts, and generalizations.

To provide for individual differences, then, Jerome Bruner recommends utilizing enactive, iconic, and symbol learnings within the framework of each learning activity for pupils to achieve key structural ideas inductively.

Humanism and the Curriculum

To provide for individual differences, humanism, as a psychology of learning, emphasizes pupils sequentially choosing objectives and learning activities in a stimulating environment. Within a flexible framework, pupils may then select mathematics experiences from among the following in ongoing units of study:

1. Programmed learning and management systems of instruction.
2. Reputable single or multiple series of textbooks.
3. Contract systems and project methods.
4. Mathematics laboratory approaches.
5. Films, filmstrips, slides and transparencies.
6. Learning stations and open spaces.

To implement a humane learning environment, pupils need to have ample opportunities to choose and select that which is purposeful and self-fulfilling.

A.H. Maslow, a leading humanist, emphasizes a hierarchy of needs that learners have which desire fulfillment. These needs in ascending order of complexity are:

1. *Physiological needs*, including adequate nutrition, rest, clothing and shelter.
2. *Safety needs*, including feelings of security.
3. *Love and belonging needs*, including being accepted positively by others.
4. *Esteem needs*, including feelings of being prized for abilities possessed.
5. *Self-actualization needs*, including the learner becoming what he/she desires to become.

The simplest needs - physiological - must be met first, generally, before increasingly more complex needs are to be met, such as safety, love and belonging, esteem, and self-actualization needs. The mathematics curriculum may then assist in need fulfillment on the part of each pupil. Each of the above named needs, except physiological, can be met in part in stimulating objectives, learning activities and evaluation techniques within the framework of mathematics units of study. Developing feelings of security, belonging, importance, and realizing one's optimal self may well become vital objectives for pupil achievement in the mathematics curriculum.

Selected References

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