Launching a Program of Individualized Math Instruction

By Clifton Keller

Starting where your students are, meeting the needs of your students, and *allowing your students to progress at their own rate* are ideals voiced by teachers and educational researchers. In attempts to reach these and related ideals, considerable attention has been given to individualized instruction. As early as 1874, Preston Search described a plan that allowed students to proceed at their own rate. Since then, periods of interest in individualized instruction have corresponded to advances in and availability of new technology. A computerized search of the ERIC data base indicated well over 8,500 articles since 1966. The early 1970s coincided with the widespread availability of audio-visual materials and produced a zenith in individualized instruction. The availability of microcomputers contributes to a current interest in the subject.

Individualized instruction, to some teachers, is defined as a specific formal program such as Individually Prescribed Instruction (IPI). Others view individualized instruction in terms of management systems such as programmed learning, contract learning, computer-assisted instruction (CAI), computer-managed instruction (CMI), or some other euphonious phrase that describes one of a variety of programs stressing a particular theory or philosophy. Many teachers who recognize differences in their students' intellectual potential and motivation, as well as desire and ability to learn, have fallen into the trap of choosing one particular approach and neglecting others. The result has been a feeling well expressed by the title of an article in *The Mathematics Teacher,* "Individualized Instruction, Sweet in Theory, Sour in Practice."

The purpose of this article is to provide a model for individualization that caters to the uniqueness

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of each child. The advice that follows is designed to assist teachers in implementing a model that will help children take advantage of their individual strengths, compensate for their weaknesses, and learn to work together for a common good.

In a traditional learning program, a certain amount of individual responsibility is generated through daily homework assignments, but students are denied important opportunities for decision making. Even tutorial programs that provide a one-to-one relationship between teacher and student often fail to meet a student's social and emotional needs. In developing a model for individualization, teachers must keep in mind the needs of individual pupils as well as their own needs. For example, the teacher must not get so involved in management details that he or she has little time left for instruction. Teachers must encourage their students to be independent and responsible, while at the same time orchestrating classroom dynamics.

The model presented on page 41 provides for a class's varied interests through a variety of teaching methods, and allows for the use of a variety of instructional materials. The model provides an overall view. Group activities appear near the top, and increased individualization farther down the chart. Under the direction of a skilled teacher, individualization can occur even in the largest groups. This model seeks to avoid the other extreme through frequent reassessment in which a student works on a learning package or programmed sequence that makes no allowance for either the student's interests or needs.

The flow chart begins with a single well-defined goal or objective—the first stage in the development of a skill or concept. The box labeled "orientation" provides an opportunity for the teacher to sell the topic. This may consist of using various methods to create an interest or providing a brief review prior to preassessment. The teacher then uses preassessment to group students according to their individual needs and interests. At this time, teachers can provide for individual differences by giving a variety of assignments. The activities at this level of instruction are brief and generalized, allowing all students to participate.

After a short period of time, most teachers will be able to organize their classes for optimal learning. If a student is bored or already well informed on the topic, he or she may be routed through the enrichment path. If students' general knowledge is adequate or they prefer to work alone, they may be routed through the practice path. These two paths are structured to allow students to assume considerable responsibility for their own learning. The third teaching path is highly structured. Division of the class into diagnostic groups presents the greatest opportunity for individualization.

On a daily basis, or even within a given class period, the teacher may reassess the situation and move students from one group to another. During reassessment, the teacher must ask if the curricular objective has been reached. If it has, the class as a whole then advances to the next objective. If not, then the teacher needs to decide whether to reassign students to enrichment, practice, or teaching paths or allow the class to advance to the next objective even though some students have not achieved the goal. It is important that the entire class proceed as a group to the next major concept.

Objectives

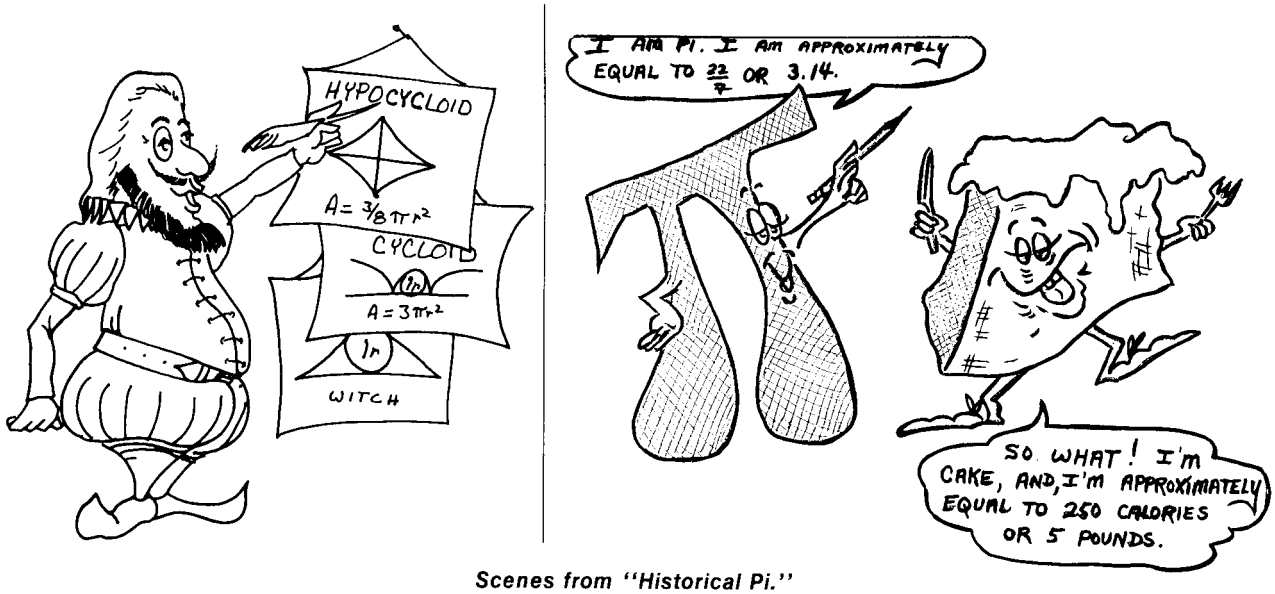
Good instruction begins with goals or objectives that have been developed through careful study and planning by a group of experienced and successful teachers in a particular school or geographic region. This list can be compared with those found in methods textbooks, teacher guides, and lists created by a state or other organizational unit. Unfortunately, these general lists are prepared without regard to sequence, and their structure and content are often inadequate. The teacher must determine whether the list meets local requirements and then begin the major task of organization, which requires planning for the appropriate sequence and differentiating between major and minor objectives.

These objectives represent the standard against which the program is compared. Attainment of the main objectives indicates student progress, whereas attainment of the minor objectives indicates breadth of learning. If students are highly motivated, they will spend more time in concentrated study and achieve a larger number of goals.

In small schools and situations that do not allow a great deal of flexibility, overall planning is necessary to prevent one teacher's program from interfering with the programs of others.

Orientation

Initially, the teacher needs to assess as rapidly as possible each child's background and sell him on the topic to be covered. This may require use of teaching methods not commonly used in mathematics classrooms, such as plays, panel discussions, and various audiovisual presentations. To introduce a section dealing with finding the circumference and area of a circle,



Scenes from "Historical Pi."

my seventh- and eighth-grade students and I wrote a play called "Historical Pi," organized as a TV news broadcast featuring Erica-Sever-Her-Hide and Walter Concrete. In this play the history of Pi was presented, leading students to understand the relation of Pi to exotic mathematical formulas by the use of such figures as the cycloid and the witch of Agnesi.

Ideas and materials can often be gleaned from publications of regional organizations, teachers' guides, and workshops during professional meetings. The Michigan Council of Teachers of Mathematics and other similar organizations periodically publish monographs in addition to helpful articles in newsletters and journals. The National Council of Teachers of Mathematics publishes *The Arithmetic Teacher* and *The Mathematics Teacher,* magazines that contain informative articles and paid advertisements. As useful as these publications may be, the richest resources are often found in students and other teachers.

At the orientation level of instruction, teachers may want to experiment with grouping, since so many of the social and emotional needs of individuals are met only through group interaction. Large group activities work well for expository instruction, while small groups are better suited to laboratory and discovery-type experiences.

Although group activities are necessary to maintain a sense of class or peer-group identity, grouping can result in a caste system. To avoid this, group membership should be changed periodically. At one time the teacher may assign group membership; at another time the groups may be created by a random drawing; and another time students may be allowed to select a group. These techniques provide frequent opportunities for change. Assigning students to groups or allowing them to select the group they prefer rather than choosing teams with a captain avoids the last-chosen feeling experienced by less-popular students.

Preassessment

The teacher should cultivate opportunities for informal preassessment through close contact with his or her students. Under such circumstances, a mathematics teacher may discover strengths that could go undetected through diagnostic testing procedures. Other methods of preassessment that can be used are asking students if they are able to solve a particular problem or giving them an exam consisting of problems for which they mark a happy or sad face for each problem to indicate whether they think they can solve it or whether the work demonstrated is correct.

Small Group and Individualized Assignments

At this point the required tasks are clearly outlined for the students. Some teachers set up formal educational contracts listing points agreed to by teacher and student, resembling the familiar, "If you practice your piano lesson, you can go out and play." Contracting through the use of carefully designed rewards can be a strong motivation for certain students. This approach offers the student a choice of several alternatives.

Formal preassessment or diag-

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to your students, they will in turn be inspired to set lofty goals and achieve great things. □

Individualized Instruction

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nosis is necessary in order to deal efficiently with individual preferences and backgrounds. Since mathematics education has a spiral organization, children need to acquire basic skills before they are prepared to move on to higher-level skills. Failure at a single point can prevent further advancement. For remedial purposes, the teacher needs to precisely determine each student's abilities and weaknesses.

Some sources suggest that pretests and posttests should include similar questions, and if students display mastery of the subject they should be channeled into alternative activities. However, this is not usually recommended. Using long division again as an example, it is clear that a pretest using long division symbols and ideas would reveal little about the present status of most students. Rather, a pretest should be designed to reveal student mastery of requisite skills such as multiplying, subtracting, and recognizing the size relationship among numbers. Preassessment allows a teacher to intelligently prescribe a self-learning capsule, counsel a child regarding the scheduling of time, and decide whether to use a firm or gentle touch in dealing with a particular student problem.

Diagnostic Groups

Following formal preassessment the model shows individualization resulting in three diagnostic groups —one group needing enrichment, another needing practice, and a third needing special direction by the teacher. This grouping should not be interpreted as representing levels of mastery, with the group needing the teacher being in some way inferior. Along the path entitled "teaching," the group may consist of boys one day and girls the next. At one time it may cater to the slow learner, and another time the fast learner.

Every student needs experiences afforded by each path, although not necessarily for each objective. In a small class the suggested structure provides for considerable breadth, for it will be almost impossible to prevent students in one group from knowing what happens in the others.

Enrichment

This path uses games and activities that will enrich the student's mathematical background and provide depth and breadth. The activities are designed to stimulate interest, arouse curiosity, and help maintain a high level of motivation. Of particular value are open-ended discovery-type experiments. Both independent and group projects can be utilized.

Children can be encouraged to conduct library research or work on favorite projects. They may prepare oral or written reports or search for jokes and cartoons that illustrate mathematical thought or problems. Under certain situations construction of geometric models will be appropriate. Some students will enjoy the creation of bulletin boards, exhibits, and other learning aids. What student could make a geoboard without learning something about measurement and asking how to use it? Often children from this group can assist students in the same or lower grades.

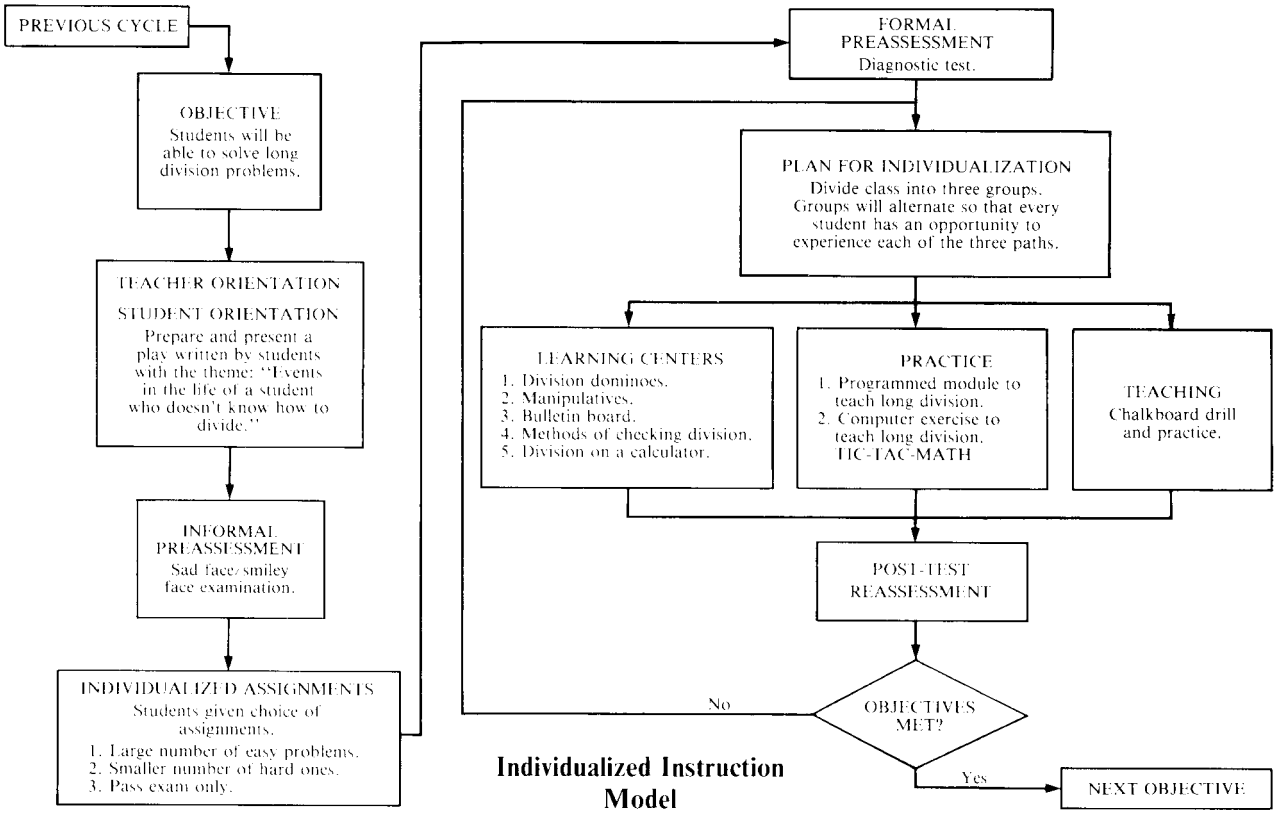
Unfortunately, this activity has often been restricted to the fast or bright student. In my classes, I have made a special point of training slower students to solve the more difficult problems and then asking them to assist others. As the student explains the problems to other students, his or her learning is reinforced by the need to repeat the experience 20 or more times. This approach has helped improve the self-image of slow students, as they gain a sense of accomplishment from helping others.

Along the enrichment pathway students show creativity as they demonstrate ways they can best contribute to their own learning. Learning centers, learning packages, math labs, computers, and teaching machines are of particular value along this path. Although a beginning teacher may be frustrated in attempting to gather the quantity of material required for this pathway, he or she should not despair, since these materials can easily be exchanged between teachers or obtained from media centers.

Practice

The practice group may need activities designed to exercise the desired skill or provide practice in a particular prerequisite skill. Modules or computer-assisted instruction, workbooks, and practice sheets provide individualization. Modern commercial manipulatives, games, and workbooks are motivational and fun-oriented. Peer-group and teacher-made games, puzzles, stories, and books also have their places. Programmed learning packages are especially valuable.

To give immediate feedback and avoid the chore of record keeping, self-checking procedures can be developed. Rather than using a published answer book, why not have complete samples of exemplary student work? One alternative to tedious record keeping is to use student assistants. This teaches responsibility and attention to



Individualized Instruction Model

detail. Along this path, as in the enrichment path, students are helped to assume greater responsibility for their own learning.

Teaching

This third diagnostic group receives special attention from the teacher. There are numerous ways that a teacher can interact with this group to provide for individual differences. Use of small groups offers significant advantages, since students who do not understand the topic are more likely to ask questions than if they were in a classroom filled with students they assume are more intelligent than they.

This group situation is not the place for minilectures or repetition of previous presentations. Instead, it should involve close interaction between students and their teacher.

This path offers the opportunity to develop one-to-one relationships between teacher and students. It provides the optimal circumstance for the teacher to make specific suggestions and point out individualized pathways to learning. If the teacher has developed a close personal relationship with the students, he or she will be better able to choose teaching aids, incentives, and methods that will best suit the needs of each student.

Advancing to the Next Objective

Because of time requirements or because the teacher recognizes adequate mastery, the entire class is again brought together and advanced to the next major objective to begin a new cycle.

Suggestions for Implementation

Fortunately, objectives can be easily obtained through teachers' manuals and local agencies. After obtaining such lists, the logical place to begin is organizing the objectives to determine where the current math program can be improved. Most teachers will choose to assess and organize their objectives as the school year progresses. Careful record keeping and gathering of materials are vital to the smooth implementation of an individualized program of instruction.

The three paths following diagnostic grouping may seem complicated. However, after materials are gathered and prepared for student use, many activities can occur simultaneously without confusion.

If the teacher consistently seeks durable diagnostic tools, challenging games, relevant literature, and other materials, an effective, well-rounded program of preassessment, diagnosis, and enrichment can be developed to meet the needs of individual students. □

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Computers and Mathematics

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nize 'appropriate' uses of computers."[31]

Choosing Appropriate Software

Here are some guidelines for teachers choosing software for mathematics instruction to consider:

1. Carefully preview software for school purchases. Choose excellent quality materials that meet the needs of your students. "Mathematical software should stress mathematical relationships, principles, and meanings" for "researchers have concluded that students will retain more, achieve higher scores on tests, and be able to transfer more to new situations if they understand what they are doing."[32] Let publishers know what kinds of programs you want.

2. Choose programs that provide an interdisciplinary, problem-solving approach and utilize the computer's unique capabilities.

The majority of computer programs now used for math can be classified as "drill and practice."

3. Consider programs that allow groups of students to work cooperatively without the necessity of continual access to a computer.

4. Choose software that allows students to use the computer the way it is used in real life—to solve problems; gather, store, and retrieve data; reorganize data; manipulate text; et cetera.

5. Choose drill and practice programs that emphasize what you consider to be really important, that are correct factually and algorithmically, and that include a management program for keeping a record of students' progress.

A New Look at What to Teach in Math

With the renewed interest in the quality of education and the feasibility of having computers in every classroom, educators have "an unprecedented opportunity to reconsider why they teach what they teach and whether they should be teaching other skills and ideas altogether."[33] Studies by Jean Piaget and others demonstrate that many youngsters have not reached the maturational level necessary to master some of the concepts currently expected of them.[34]

Adventist educators must decide how to restructure the scope and sequence of math instruction to best meet the needs and abilities of individual students, particularly in the context of multigrade classrooms. Now is the time to integrate computers into the curriculum to take advantage of their capabilities to help each student develop his or her fullest potential.

Since "computers used for in-

Sources of Software for Preview

- Local computer stores and dealers, some of which have an educational consultant and will allow previewing of any material they carry.
- Catalog companies that have a 30-day return policy—the format of many otherwise good programs is not suitable for church schools, and catalog listings may not describe the format.
- Local, county, or state agencies dealing with computers in education.
- Local school districts.
- Computer users groups in your area.
- Other teachers in your conference.
- Public service television programs that preview software for teachers.