

Individualized instruction in mathematics



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Editor's Note: The ideas found in this article are being implemented in a project concerned with individualized instruction in Grade VII mathematics at Hardisty Junior High School in Edmonton.

What is meant by individualized instruction in mathematics?

Individualized instruction in mathematics is instruction with which is attempted to take account of individual differences between students on factors influencing the learning process of mathematics. These factors include

1. mathematical ability,
2. previous achievement, knowledge and skills in mathematics,
3. rate of assimilation of mathematical ideas and skills,
4. extent of practice needed to develop skills in mathematics,
5. depth of assimilation of mathematical ideas.

With this kind of instruction, attempts may also be made to account for individual differences between students on such factors as

6. interests in mathematics,
7. ability to accept responsibility for learning,
8. independence,
9. motivation and attitude toward mathematics,
10. learning style.

The individualized teaching method allows most students to receive instruction individually by working independently from materials specially prepared for independent study. On occasion, students may also work in small groups. The range of individual differences between students tends to make independent study necessary if this range is to be adequately accounted for.

Why individualize instruction in mathematics?

One of the reasons for such instruction is to take account of the individual differences listed earlier. Very able and interested students can move ahead more rapidly at greater depth and in greater breadth than average and less able students. The latter can similarly progress at their own rate on materials geared to their level of performance.

Secondly, this approach will hopefully result in equal or superior mathematics achievement to that obtained in the traditional setting; and it will expose able students to a far greater range of the mathematics spectrum than they meet in the traditional setting.

Thirdly, gains are expected in areas other than mathematics achievement - for example,

- attitude toward mathematics and the learning of mathematics,
- independence, acceptance of responsibility, self-direction, decision-making,
- attitude toward school, teachers, and authority.

Is individualization of instruction, as described here, new?

Many teachers have practised limited forms of individualized instruction when they attempted to cater to individual differences by such means as groups within classes, differentiated assignments, remedial work, enrichment and individual assistance. Formal approaches in the past have included such methods as the Dalton Plan and Winnetka System. The form of individualized instruction to be described is new to the extent that it attempts to more thoroughly cater to individual differences than other methods.

What has accounted for the renewal of interest in individualized instruction?

There are probably several courses which include

- programmed instruction, its use in instruction and as a research tool,
- computer-assisted instruction and the flexibility it offers in catering to individual differences,
- team teaching and efforts at more effective utilization of school staffs,
- non-graded approaches to instruction.

What are some of the particular characteristics of individualized instruction in mathematics as it has developed in recent times?

1. Behavioral objectives. In individualized instruction it is very important that those involved in preparing the materials to be used have very clearly in mind the particular behaviors which are intended to be developed by the students.

This is important in any form of instruction but particularly so in individualized instruction. Students are working independently without the presence of a teacher who will either say or show (through examples, exercises, and test items) what they are expected to learn and do.

These behaviors should be set out in detail and given to the student so that he can clearly see what is expected of him.

2. Pre-tests. A pre-test for a topic is a test with items including all the behaviors which the student is expected to develop during the topic. There is a test item for each behavioral objective.

The reason for pre-testing is that the student does not waste time during the study of a topic on things that he can already do - he may show that he has achieved certain of the objectives for a topic before studying the topic.

Pre-testing is particularly important in today's approach to mathematics teaching, an approach in which ideas are introduced on several occasions, each time at greater depth, in the course of the mathematics curriculum.

By pre-testing, individual differences in previous knowledge are catered to in a way which would be difficult to carry out in a regular classroom. The student is not expected to study parts of a topic which he already knows. A pre-test also reveals items which are included in the topic. Of course, students have to get used to pre-tests since it is normal for many of them to perform quite poorly on the pre-test. They must see it as an aid to learning and not as some grading device.

3. A brief introduction to each topic. The introduction puts the topic in perspective for the student by telling him

- (a) what the topic covers in general terms,
- (b) why the ideas in the topic are important,
- (c) how the topic fits in with other mathematics he has learned and perhaps how it relates to what he will learn later,
- (d) how and where the ideas in the topic are used both in the school mathematics course and in applications outside the mathematics course.

The introduction is primarily to give perspective and to provide motivation

4. Independent study materials. Desirably this is material written specifically to help students develop the behaviors included in the objectives for a topic. As such, the material is expected to introduce and discuss the mathematical ideas and skills to be developed and to provide opportunities to practise with these. Sometimes, although not very often, it may be possible to use existing school texts for this independent study material. The material must be tied closely to the objectives, and it must be readily apparent to the student to which objectives it applies.

5. Progress check items. These are test items which assess whether the student is making adequate progress through a topic. They are used to tell when he is ready to move from one part of the topic to the next. The items may be in the form of exercises which, if they can be done correctly by the student, show he is ready to move on to the next part.

6. Summary and review. At the end of each topic, there should be some form of summary and perhaps review exercises which tie together the ideas developed in the topic.

7. Post-test. A post-test for a topic is a parallel form to the pre-test, having an item for every objective. On this test, given at the completion of the topic, the student demonstrates his achievement of the objectives for the topic. Students would normally do only items for objectives they did not achieve on the pre-test.

Note that the tests used in individualized instruction are what might be called "criterion-referenced" tests. There is an item for every objective, *not* just a representative sample of items. The emphasis in testing is on the achievement of an objective by the individual - for evaluation, diagnosis and as an aid in learning the behaviors for the topic. The emphasis is *not* on comparisons between students for the purpose of grading. The tests are *not* "norm-referenced" tests.

8. Follow-up materials. These are for students who do not achieve adequately on the post-test; they provide re-teaching as it is needed. Again, these materials are tied to the objectives. Often 80 percent of objectives achieved is considered the criterion for advancing to the next topic.

9. Records. Individualized instruction usually has very detailed record-keeping procedures associated with it. This is necessary as students are normally working at varying points in the material due to the varying rates of progress. Most recording materials include

- (a) the student's name, class, course, and topic;
- (b) percentage of objectives achieved on pre- and post-tests or an actual record of when each objective is achieved;

- (c) remedial work required and success on this;
- (d) comments.

10. Enrichment. Desirably there should be opportunities for more able students who progress more rapidly, to look in greater depth at ideas presented in each topic, and also to be exposed to a wide range of additional materials and topics.

What is involved in developing individualized instructional materials of the type described?

A very substantial task is to develop materials for individualized instruction on a large scale - that is, for a full year course or for a whole curriculum, and to do it so as to thoroughly implement each of the points dealt with earlier. *It is far beyond what can be reasonably expected of teachers who also have a regular teaching load.* The task needs to be tackled by people, preferably teachers, receiving some help and guidance from those who have had experience in developing such materials, who can devote a considerable amount of time to the task. Presumably this sort of thing will be tackled on a large scale at some time in the future.

What can teachers do about individualized instruction here and now?

On a small scale and at the present time, it is feasible for teachers (even with a full teaching load) to develop one or perhaps two topics along the lines indicated in any one year. This would come to about two weeks per month of individualized work for average students. Experienced teachers who are not overburdened with lesson preparations now do a great deal of things in addition to the routine task of teaching. Preparation of individualized instructional materials could be one of these things. Or, even more desirably, a team of teachers in a school, with classes in the same grade or with common interests, could work cooperatively to develop topics. Different people could take responsibility for different aspects after team planning. This could be a very valuable inservice activity.

In junior high school, the mathematics academic elective offers a golden opportunity to develop topics for individualized instruction along the lines discussed.

To become involved in these things *now* will give teachers extremely valuable experience in the use of individualized instruction - experience from which they will greatly benefit as the individualization of instruction becomes widespread.