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# Teaching Aids in Mathematics

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# TEACHING AIDS IN MATHEMATICS

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## TEACHING AIDS IN MATHEMATICS

For many years, mathematics classes have had a traditional aura about them. The textbook has been the major source of material. The typical lesson consists of review assignments discussed in class, presentation of the new material usually by the teacher, some applications of these new concepts, and a homework assignment for the next day. This routine is repeated from day to day, term to term.[1] The students are acting merely as machines. The teachers ask questions, and the students answer from memory. This is one of the main reasons why there is a lack of understanding in mathematics classes.[2]

Some memorization in learning is required, but the contention is that it can and should be minimized. Mathematics is a topic that cannot be learned by sheer memory. A student of mathematics must minimize memorization and maximize reasoning to find the correct method for a problem. If a student has something tangible that he can hold, see, feel, and better yet if he can make it for himself, much more retention of the subject is possible. Through the use of instructional aids memorization can be minimized and the student's imagination will be challenged. He must still reason to solve problems, but imagination acts as a stimulus to reason.[3]

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[1]Irvin Kaufman and Stephen Krulik, Multi-sensory Techniques in Mathematics Teaching (New York: Teachers Practical Press, Incorporated, 1963), p. 1.

[2]L. A. Kenna, Understanding Mathematics with Visual Aids, (New Jersey: Littlefield, Adams and Company, 1962), p. 1.

[3]Ibid.

Instructional materials then are as essential for the mathematics teacher as spices are for the chef. Since mathematics is an abstract, logical science, mathematics teachers have a special need for instructional materials that lend reality to idea.[4] Multi-sensory aids enable us to teach with materials that do not depend primarily upon reading aids. Teaching consists of communicating ideas, concepts, and skills to the learner. Audiovisual aids can accomplish this communication in a manner that is stimulating, expedient, enjoyable, and profitable to both the teacher and the learner.[5]

The question arises on how to select the aids which will make teaching more effective and learning more efficient. Consideration in the selection and use of aids to improve learning should include (1) the level of conceptual difficulty and abstraction of the aid; (2) instructional time needed; (3) complexity involved in the manipulation of the aid; (4) desirability of each pupil having the aid; (5) the possibility of using the aid to develop more than one mathematical concept.[6]

Mathematical teaching aids, generally fall into three broad categories. First are the literature aids which add enrichment, broaden the background of the students, and stimulate curiosity.[7]

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[4]Donovan A. Johnson, "Instructional Materials in the Mathematics Classroom," National Education Association Journal, 56:39, May, 1967.

[5]Kaufman and Krulik, loc. cit.

[6]Harold H. Lerch and Charles T. Mangrum II, "Instructional Aids Suggested by Textbook Series," Arithmetic Teacher, 12:543, November, 1965.

[7]Johnson, op. cit., p.40.

Secondly are the audiovisual aids such as films, filmstrips, video-tapes, overhead projectors, television and radio.[8] The overhead projector is one of the most potentially valuable aids. In using this machine, the teacher faces his class, while information is projected over his shoulder, to the front. Thus class attention is focused upon the projection while the teacher can watch the class for questions. Also the students to the rear of the class can easily see the large clear diagrams and materials. To discuss some topic later in the class period or even the next day, overlays can be used. Difficult material and diagrams can be prepared in advance and saved to be re-used in future years. An overlay is an extra piece or two of celluloid, usually hinged with a piece of masking tape to the frame. These may be placed over the original stencil and written upon or used to add to the diagram as needed.[9]

How is this machine operated? First of all, the materials must be prepared by transferring them to stencils made of celluloid with a surrounding cardboard frame. These stencils are placed on the machine, where they are projected onto the wall or screen. The stencils are prepared with special types of grease pencils or ink. The projection is accomplished by the blocking of light by the lines made by the grease pencil.[10]

In the eleventh year mathematics course, the lesson in the number of intersections of algebraic curves causes teachers and pupils considerable

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[8]Johnson, <u>op</u>. <u>cit</u>., p.40.

[9]Kaufman and Krulik, <u>op</u>. <u>cit</u>., p. 40.

[10]<u>Ibid</u>.

difficulty. The difficulty arises from the need to "move" curves in order to demonstrate all possible situations. When the overhead projector is used for a lesson like this, it is possible to prepare the following materials which can be kept from term to term:

(a) a stencil of a graph grid
(b) a large parabola overlay
(c) a circle overlay
(d) a hyperbola overlay ($ax^2 - by^2 = c$)
(e) a hyperbola overlay ($xy = k$)
(f) a straight line grid.[11]

Another use that can be made of the overhead projector is in teaching students how to read tables such as the logarithmic or trigonometric tables. Also by cutting small channels in the celluloid overlays, it is possible to illustrate some locus problems by actually moving the lines involved using eyelets.[12]

There are vast curricular changes in mathematics. Innumerable workshops, courses and institutes are springing up to educate mathematics teachers to this change. There are some problems with this however. It is difficult to provide workshops or other training courses for a significant number of teachers of mathematics. Many teachers teach more than one subject and could require re-education in as many as three or four areas. One solution to these problems may lie in the use of newer media, particularly radio and television. In his booklet What Psychology Can We Trust? Goodwin

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[11] Kaufman and Krulik, op. cit., p. 40.

[12] Ibid., pp. 41-2.

Watson states:

> Television is qualilatively as well as quantitatively influential. The pictures and sound have a life-like impact, far more impressive than print. Communities deeply concerned about finding better textbooks have given very little effective attention to the more potent educational medium.[13]

There are four principal uses of television as an instructional medium. They are in-service teacher training, classroom instruction, enrichment and provision of a course in mathematics not otherwise available.[14]

The following is a typical example of the use of television in a junior high school. In the Arlington Heights Public Schools, the design for closed-circuit television began with the planning of a junior high school in 1957. The pressure of increasing enrollments and strong demands on the financial resources of the district deferred the installation until the spring of 1965. By 1967, there was a fully equipped television studio.[15]

In the junior high school, each of the three closed-circuit installations is designed for exclusive use of a single building with personnel within each building assigned responsibilities for programming. Programs may be shared with other buildings through exchange of prepared videotapes.

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[13] Robert R. Suchy, "Radio and Television in Science and Mathematics," National Association of Secondary School Principals Bulletin, 50:126, October, 1966.

[14] "Television in Mathematics Education," Arithmetic Teacher, 14:598, November, 1967.

[15] James Montgomery, "The Use of Closed-Circuit Television in Teaching Junior High Mathematics," School Science and Mathematics, 68:747, November, 1968

Each of the studios is equipped with two vidicon cameras, a videotape recorder, a video-modulator, a switching device, and other relative equipment such as lights and microphones necessary to televise high quality presentation over an RF distribution system.[16]

What are the objectives of this? Proper use of the media brings about more effective use of teacher time and directs the teacher's efforts toward the individual need of students. The quality of lesson presentations improves. The educational experience of students is expanded by utilizing outside talent.[17]

The third category of teaching aids is models and manipulative materials. Some of these are demonstration aids such as the number line, hundred board, an area demonstration device, and a slide rule. Laboratory devices consist of such instruments as place value boards where boards are fitted with pockets to teach the place value of a numeration system, number sticks, spin dials, area aids, and geometry boards where pegboards are designed to demonstrate formulas and theorems by use of pegs and string. An assortment of other instructional aids is available. Computation devices such as calcualtors, abacuses, and computers may be used.[18]

Two problems that are marginally possible without a calculator, but that might be easier with one are an intuitive approach to the law of exponents and an intuitive approach to the Pythagoras theorem.[19]

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[16] Montgomery, op. cit., p. 748.

[17] Ibid. p. 749.

[18] Johnson, op. cit., p. 40.

[19] Frank Van Atta, "Calculators in the Classroom," Arithmetic Teacher, 14:650, December, 1967.

The abacus is not as automatic as electronic computers, but in many respects it is superior to such machines. The down time of some electronic computing machines is twenty-five per cent. The abacus is reliable (no down time), and with some practice it can become a valuable assisting agent in computation. By using this instrument, the only mental process involved is the actual computation. The abacus performs the necessary memory work. Its chief advantage is the economy of time. The numbers on the abacus are represented by wooden beads, systematically arranged on a frame that constitutes the abacus. The abacus can be used for addition, subtraction, multiplication, division, and finding square roots and cube roots. The answers obtained depend only on the size of the abacus, the number of columns of beads, and the ability of the operator to avoid careless mistakes. The abacus is a very useful aid and is a forerunner of the modern computing machine.[20]

Cost is the main hindrance of the use of computers in secondary schools. This problem is being somewhat alleviated due to the intriguing development of the time-sharing monitor or operating system whereby several programs may be run simultaneously through a large machine. With a remote control console placed in a classroom or on a portable platform, the instructor and students essentially have most of the facilities of a large-scale system available on demand. A computer system was set up at the University of Minnesota in mid-1965. The students in the pilot experiment had access to

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[20]Kenna, op. cit., p. 114.

the teletype console which was connected directly by telephone communication to the computer. Thus programs could be run, and results obtained as soon as the students had collected the data. Students could experience the satisfaction of communicating with the computer themselves; this served as a great motivating as well as instructional aid. The pre-stored program, POLFIT, required only that pairs of (x, y) data points be put into the machine. The computer then produced the equations of the best first, second, third, . . . eleventh degree curves through these points. The second pre-stored program, XYPLOT, required only that an equation be put in. It was capable of plotting a graph of any equation put in if proper limits and parameters were provided. There was no programming on the part of the students. The students needed only to collect the data, analyze it with the aid of the computer, and interpret results. The students all gained a better understanding of mathematics.[21]

The following are examples of other instructional aids in various areas of mathematics. There is a series of aids manufactured by the W. W. Welch Scientific Company, Chicago, Illinois, called the "Dynamic Geometry Instruments." One important figure which can be used extensively for many theorems and concepts is the "Dynamic Extensive Triangle with Constant Midpoints." It is useful in teaching lessons on the intersection of the medians, the segment joining the midpoints of two sides of a triangle, and relations between altitudes and medians. At the end of each lesson, several of these instruments might be passed around so that the students can handle

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[21]Kenneth W. Kelsey, "Exercises in Computer-Assisted Physics and Mathematics," School Science and Mathematics, 67:119-123, February, 1967.

the models and get the "feel" of the median, an altitude, etc. Also there are models of the "Dynamic Quadrilateral" with adjustable sides that form a square, rectangle, parallelogram, etc.[22]

One firm, the Dictation Disc Company, 170 Broadway, New York, New York, has come up with another aid for geometry teaching. This one is audio, rather than visual. It is called the "DDC Learning Aid for Geometry." It consists of a twelve-inch long-playing record containing 350 odd facts, all needed in geometry. The items are grouped by definitions, postulates, and theorems. The recording is accompanied by a transcript of each fact on the disc.[23]

For the more advanced students, the Library of Science, 59 Fourth Avenue, New York, New York has several kits which effectively illustrate mathematical principles. Their "Brainiac K-30" and "Geniac" kits enable the student actually to build and use simple computer machines which perform experiments in logic and mathematics. One kit which can be helpful is their "Probability and Statistics Laboratory." In the twelfth year, for example, the kit can be used to perform experiments in sampling (white and black beads are used as the "population"), coin flipping to demonstrate the concept of a central tendency, probability by the use of a pair of dice, etc.[24]

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[22]Kaufman and Krulik, op. cit., pp. 44-5.

[23]Ibid.

[24]Ibid., p. 49.

Curve-stitching is a welcome change from the usual tyranny of pencil and paper. Basically it consists of constructing straightline envelopes by stitching with colored thread of yarn. A student is able to make patterns of a parabola, hyperbola, ellipse, etc.[25]

As one can see there are many aids that may be used to promote and stimulate learning of students in the field of mathematics. These are only a few. Within a few years, maybe all schools will be able to have instructional aids of some kind.

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[25]Kenna, op. cit., p. 44.

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