

*Toward a modern program of*

## Mathematics in High School

DURING the past half-decade much has been written about the changing aspects of the mathematics curriculum in the high schools. Not only has much been said about the changes but, far more significantly, much has been done in very concrete ways about upgrading the mathematics instructional program in the precollege grades.

To those who have been skeptical of the proposed changes in the curriculum and to those who have been waiting to see what "the other fellow" is going to do about implementing any changes, the writer would dare suggest that the waiting game must now be over and that well-directed action toward improving local mathematics instruction should proceed without delay. One needs only to read the current literature regarding mathematics education—literature written by reputable and informed representatives of the mathematics community—to realize that the results of experimentation with new curriculum materials are far too convincing of the value derived from these materials to be ignored. The "thinking educator" has already taken steps to incorporate the viewpoint and content of current mathematics curricula into the local instructional program. There are many, how-

ever, who have not done so. It is in this group that the writer would hope to stimulate a desire and realization of the need for the consideration of "step-taking" procedures toward improving the local instructional program.

The National Council of Teachers of Mathematics published in late 1961 a booklet entitled, *The Revolution in School Mathematics*. In this publication the need for curriculum improvement, the kind of changes proposed, and the steps toward implementing these changes are very definitely set forth by scholars who are well prepared through knowledge and experience to provide such information. The writer, while echoing here some of the ideas proposed in this booklet, urges that the publication be read thoroughly and thoughtfully by all administrators, supervisors and teachers whose responsibility is the improvement of mathematics instruction.

Today, mathematical literacy is imperative to a degree that has been unprecedented in the history of the world.<sup>1</sup> On the other hand, it cannot be ascertained just what mathematical knowledge will be required of future citizens when they assume leadership roles in directing our society. There is general agreement on one point, however, and that is: young people must be exposed to the kind of

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Isabelle P. Rucker is Supervisor of Mathematics, State Department of Education, Richmond, Virginia.

<sup>1</sup> Marshall S. Stone. "The Revolution in Mathematics." Washington, D. C.: Mathematical Conference Board.

mathematics content and instruction that will be basic and adaptable to whatever scientific, technological and social innovations may occur to mankind through chance or necessity.

Materials such as those prepared by the University of Maryland Mathematics Project, the University of Illinois Committee on School Mathematics, the School Mathematics Study Group, Ball State, *et al.*, while differing slightly in certain aspects, have one aim: namely, to develop the concepts of mathematics through the structure of mathematics, not through a disconnected assemblage of manipulative "tricks." The algebra student who understands, for example, that  $4a+3a=7a$  because of a basic law of mathematics (the distributive law) and not because  $4 \text{ apples}+3 \text{ apples}=7 \text{ apples}$ , is learning an important concept of mathematics from the standpoint of the structure of the science. Commercial textbooks now coming off the presses contain the content and point of view of mathematics as projected in the materials of the several writing groups of recent date. This fact is encouraging and its significance has far-reaching implications for all of us.

### Questions and Answers

The need for improving the mathematics curriculum is clear; the materials reflecting the content of courses for high school mathematics are mathematically sound in light of the needs of the twentieth century and these materials are available in teachable form. What, then, are the steps that must be taken by local administrators, supervisors, teachers and others responsible for mathematics education? Each of the following step-taking suggestions is proposed in the form of a sequence of questions; the questions are

followed by a chronological order of proposed answers to the queries.

1. Are local administrators apprised of and sympathetic to the need for curriculum improvement?

2. Is the mathematics background of the teaching staff up-to-date in light of contemporary mathematics?

3. Have teachers studied the content of current mathematics curriculum materials as though they themselves were learning it for the first time?

4. Are teachers knowledgeable of and amenable to the philosophy of and techniques of teaching the newly developed courses?

5. What knowledge on the part of students is presupposed for a specific course?

6. Is there provision for continuous in-service study and counsel?

7. Are guidance counselors aware of the ever-expanding uses for mathematics in fields other than the mathematical and physical sciences?

8. Are parents informed of and attuned to the basic need for change in the mathematics curriculum?

Those persons whose interests and activities are directed toward a specific subject field must realize that administrators are responsible for the total school operation and that each administrator is eager to provide the best education possible for the students under his charge. It becomes incumbent, therefore, upon the so-called "specialist" to keep administrators informed of the progress and trends in specific subject fields. Teachers, local supervisors of mathematics, directors of instruction, and supervisors on the state level must communicate freely with administrators through consultations, conferences, printed materials, etc., the urgency for improvement in the mathematics curriculum. The writer can document the successes of such a procedure when handled with competence, patience and common sense. A school administra-

tor who believes sincerely in the worth of the current approach to the study of mathematics is, in the opinion of the writer, the strongest influence toward implementing a change in the curriculum.

Teachers who have availed themselves of opportunities to study mathematics from a contemporary point of view are ready to begin a serious study of curriculum materials as prepared for students. Those who have not, need help. This help may be provided through activities such as summer mathematics institutes, academic year institutes for teachers of mathematics, in-service institutes on the local level, concentrated self-study, and contemporary mathematics courses offered at nearby colleges and universities. It must be recognized that some teachers find it impossible and/or impracticable to participate in these activities and, for them, other means must be devised. One such means is through the use of a teacher on the local level who is well-informed on current developments in mathematics. This individual can be a valuable asset in directing a local in-service study in contemporary mathematics.

In some states, members of the mathematics staff of state departments of education are available to conduct in-service programs in contemporary mathematics. This plan works to best advantage when participation on the local level is voluntary, though expected to be continuous for a set period of time, and when the leadership is enthusiastic and well-planned. The use of a particular guide or textbook in the hands of each participant aids in assuring continuity and directed purpose to the program. The writer believes that credit, per se, for such courses should be a negligible factor, since true credit will be derived

from the inspiration and renewed zest for mathematics teaching that evolve when teachers understand the "modern" content and point of view of contemporary mathematics.

Once the mathematics background of teachers is considered to be adequate, there should be instituted a concentrated study of a set of curriculum materials prepared by a contemporary writing group. Consider, for example, the writings of the School Mathematics Study Group, grades 7-12. Each student's text is accompanied by a teacher's commentary in which the mathematics behind the concepts being developed is clearly explained. (Incidentally, answers to problems in the student's text are included, also!) It is very important that the commentary be studied *along with* the student's text. If such an in-service activity is pursued conscientiously, participating teachers will gain a "feel" for the content, the point of view, and the philosophy behind the writing so that they will then be prepared to handle the materials in a classroom with a sense of security and direction. This study should begin at least one semester, preferably one term, prior to the use of the program with students.

Especially during the first year that a contemporary mathematics curriculum is taught in a school, it is important that members of the mathematics staff of schools confer frequently with one another in uninterrupted sessions set aside for such purpose. Experiences of teachers who have taught the new materials for the first time indicate that students often ask searching questions that require concerted opinion of a group of teachers before an honest reply can be proffered.

The student's role in the improved curriculum proposal is very important.

While there are some extremely capable teachers who can teach, e.g., SMSG's "Intermediate Mathematics" to 11th graders who have been exposed solely to traditional mathematics courses, it is reasonable to assume that the current materials should be introduced in the seventh or eighth grades and continued through high school.

It is not impossible for students to begin the study of contemporary elementary algebra, for instance, without some experiences in abstract thinking and the structure of the number system. Such procedure, however, requires that the teacher be prepared to anticipate the necessity for exposition of background knowledge which the materials assume. Teachers of the new materials are ready to admit that students pick up the ideas presented quickly and with much enthusiasm; perhaps the most obvious reasons for this are that (a) mathematics in itself is an interesting study when approached from the standpoint of structure, and (b) students have little or no "unlearning" to do, while adults who have been through traditional programs have to recondition their minds and attitudes to the new materials.

Some psychologists believe that all students can assimilate some of the ideas in current mathematics curricula.<sup>2</sup> This tenet has been borne out in classroom experience where it has been demonstrated that through the study of contemporary materials students are expressing a degree of interest in mathematics that has never before been aroused. For this reason, some of the current materials, while written originally for the college capable students, have been adapted for use by the student who is not considered to be a particularly apt abstract thinker.

<sup>2</sup>Jerome S. Bruner. *The Process of Education*. Cambridge: Harvard University Press, 1960.

The depth of understanding to be expected is less than that for the college capable student, and the pace at which the materials are covered is much slower. Use of these materials for the so-called general mathematics students is becoming more and more widespread.

In most high schools every student in a particular class has been assigned to that class after consultation with the guidance personnel. For this reason, it is imperative that the guidance staff be kept up-to-date on proposed changes in the mathematics curriculum. The well-informed guidance counselor of today is aware of the expanding uses for mathematics in the social sciences, the biological sciences, business, industry, psychology, and other fields. Consequently, they are ready to advise certain students of the need for the study of mathematics in high school even though their interests are not directed primarily to the mathematical and physical sciences. The guidance counselor must have a broad knowledge of the entire curriculum in a school. It is imperative, therefore, that those responsible for mathematics instruction communicate freely with these counselors to keep them abreast of the purposes of the changing curriculum.

A vital, though often neglected, aspect of the proposed changes is the part that parents play. A parent, well informed as to the need for curriculum revision toward the modern point of view and the basic aims of this revision can be an important disciple in promoting the success of such changes. In the event that seventh-grade Jimmie remarks, at the dinner table one evening, that the sum of 2 and 5 is not always 7, the repercussions from uninformed parents may be immediately detrimental to the program. However, should the parents be aware that

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Then one amazing day, with calm de-  
liberation,  
the teacher gave the structure  
a firm and mighty shove.  
And as the dust settled,  
she pushed through the debris  
and spread it widely apart.  
Then she took time  
to observe, to consider,  
to search out a place  
to start again.

The teacher selected one iridescent  
particle.  
She scrutinized it from all sides.  
She pushed through the many colors,  
worked past the inviting sheen.  
She tested, checked, and prodded.  
She honed it down to a oneness.  
She dissected,  
then described,  
reducing it to the essence  
of its own reality.

She reached into the web of her imagina-  
tion  
to find a way to explain  
all that she dimly sensed  
about this one particle.  
She turned to passages in books.  
She dug back into the past.

She played with it,  
placing it first  
in the center of one pattern,  
then on the edge of another.

The teacher was beginning to know  
several particles well.  
She sorted and weighed and sought.  
This one belonged with another.  
A third must be set aside.  
Here was one that might be a key  
to the pattern of a whole.  
And from the confusion  
spots of harmony  
and relatedness  
began to emerge.

Week followed weary week, and still  
she persisted.

There were doubts of self.  
There was discouragement,  
relieved by tantalizing glimpses  
of a path that she might follow,  
a direction she might go.

When asked why she persisted  
she could only say—  
"To draw the fragment of a dream,  
to some day answer someone's need."

—MARY HARBAGE, *Editor, News Ex-  
plorer and News Trails, Scholastic Mag-  
azines, Inc.*

## High School

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such ideas are taught for specific reasons,  
then they will most likely boost the pro-  
gram and assist in overcoming difficulties  
which might otherwise be stumbling  
blocks to the success of the program.

Avenues such as the local news media,  
presentations at local civic and profes-  
sional organizations, "back-to-school-  
night," printed materials prepared espe-  
cially for and distributed to parents,  
programs offered by the school which  
are designed particularly for parents are  
some of the procedures that have been  
tried successfully in certain localities  
throughout the country. The writer be-  
lieves that no one of these is sufficient  
within itself, but that a combination of

such ideas and others that will occur to  
local administrators should be pursued.  
Iteration is necessary here: *parents must  
be kept informed.*

Once a locality has implemented a re-  
vision of the mathematics curriculum, the  
local school authorities should engage in  
a constant state of evaluation and re-  
evaluation of the program. Nothing be-  
comes so static as a program that is al-  
lowed to "rock along" without constant  
vigil and alertness to pitfalls that should  
be dealt with at the earliest possible  
moment. No one program as now con-  
ceived is designed to be a panacea for  
the ills of mathematics instruction. Nev-  
ertheless, through the use of one such  
program, a local program adapted spe-  
cifically to local needs and feasibilities  
can be built. The time to act is now!

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