Student Needs and Subject Requirements -- Can One be Met Without Sacrificing the Other?

The real issue in the '70s is to improve teaching strategies to effectively use the materials presently available - and adapt them to meet the needs and interests of the students. Are we equal to the challenge?

WALLACE S. MANNING

School District #91
Idaho Falls, Idaho

When I accepted the invitation to speak at this session of your conference, I deliberated on what I could discuss with you that would be worth your time, because I feel a deep sense of responsibility for providing a few ideas which will repay you for your attendance at this meeting. I thought about an open letter from Dan Valentine, a columnist for a Salt Lake City newspaper, concerning his son starting school. In the letter he lists some basic and important matters to be considered by every teacher at every level. The letter reads something like this:

Dear World:

My young son starts to school today. ... It's all going to be sort of strange and new to him for a while, and I wish you would sort of treat him gently.

You see, up to now he's been king of the roost... He's been boss of the backyard. His mother has always been near to soothe his wounds and repair his feelings.

But now things are going to be different.

This morning, he's going to walk down the front steps, wave his hand, and start out on the great adventure... It is an adventure that might take him across continents, across oceans, ... It's an adventure that will probably include wars and tragedy and sorrow... To live his life in the world in which he has to live will require faith and love and courage.

So, World, I wish you would sort of look after him... Take him by the hand and teach him things he will have to know.

But do it gently, if you can.

He will have to learn, I know, that all men are not just, that all men are not true.

But teach him also that for every scoundrel there is a hero, that for every crooked politician there is a great and dedicated leader. Teach him that for every enemy, there is a friend.

It will take time, World, I know. But teach him, if you can, that a nickel earned is of far more value than a dollar found. Teach him to learn to lose so he'll enjoy winning that much more...

Steer him away from envy if you can ... and teach him the secret of quiet laughter.

Let him learn early that bullies are the easiest people to whip in the schoolyard... Teach him, if you can, the wonders of books. But also let him ponder the eternal mystery of birds on the wing, and bees in the sun, and flowers on a green hill.

In school, World, teach him it is far more honorable to fail than to cheat. Teach him to have faith in his own ideas, even if everyone says they are wrong...

Teach him to be gentle with gentle people and tough with tough people.

Try to give my son the strength not to follow the crowd when everyone is getting on the bandwagon. ... Teach him to listen to all men - but teach him also to filter all he hears on a screen of truth and take just the good that siphons through.

Teach him, if you can, how to laugh when he's sad. Teach him there is no shame in tears... Teach him there can be glory in failure and despair in success.

Teach him to scoff at cynics and to beware of too much sweetness... Teach him to sell his brains and brawn to the highest bidder but never to put a price tag on his heart and soul.

Teach him how to close his ears to a howling mob ... and to stand and fight if he thinks he's right.

Teach him there are times when a man must gamble... And there are times when a man must pass the dice.

Treat him gently, World, if you can. But don't coddle him... Because only the test of fire makes fine steel. Let him have the courage to be impatient. Let him have the patience to be brave. . .

Let him be no man's man... Teach him always to have sublime faith in himself.

Because then he will always have sublime faith in mankind.

This is quite an order, World, but see what you can do... He's such a nice little fellow, my son!

Dan Valentine

As you reflect on that letter, you find any number of challenges which we could discuss in the next few minutes, but there is one that I would like to review with you: "Take him by the hand and teach him things he will have to know." There is a challenge!

What mathematics will your students have to know in the next year - five years - ten years? What will the world be like in 1985? To try to get some feeling for the magnitude of the problem, let's take a short look at what has happened in the last 15 years.

FIFTEEN YEARS AGO:

1. The U.S.A. placed its first satellite in orbit. (Russia had startled the world with its Sputnik one year earlier.)
2. Jets were beginning to cross the oceans.
3. There were no supersonic commercial jet liners, communications satellites, and space agency.
4. The so-called "New Math" was about to make its appearance.

In this 15-year period, 12 men have trod the moon; we have just witnessed the conclusion of the second extended sky lab experiment where three men spent 59 days in an orbiting space laboratory. All in this world were able to watch the living color transmission from China by satellite as President Nixon made his recent trip to that country. The supersonic jet transport - the Concord - has made its first flight to the American continent.

During this 15-year period, we have gone from a situation of surplus energy - especially electricity - to a point where we face a very serious energy crisis.

FIFTEEN YEARS FROM NOW:

What dramatic changes will we see in the next 15 years? What will the world be like? It is really quite difficult to predict. However, here are a few suggestions that will have a significant impact on all of us.

1. Space communications will play an increasingly important role in education. In 1974, an experiment will be conducted in the Rocky Mountain States using the ATS-F satellite. This project will bring some unique educational opportunities into remote areas of the states. There will be direct two-way communications between the remote areas and the project center via the satellite as well as TV broadcasts.

   (a) We are moving into the computer age. Schools need access to large-scale digital computers - either on a local or regional basis. Space communications can play an important role in making such a computer system available.

   (b) Libraries and universities could be tied together through a communications network. With the "knowledge explosion" and great mass of printed materials, it will not be feasible for each library to maintain a comprehensive collection of pertinent materials in all areas. With the use of micrographics, most of the books in the world could be made available to schools and universities.

2. Weather satellities are in operation now, and it is likely that we will have a global weather network for long-range forecasts as well as disasters and emergencies, and even weather management is a possibility.

3. The development of the resources on earth and global crop management and prediction have far-reaching implications to us all. Orbiting satellites offer real hope in achieving major advancements in these areas.

4. Space sensors may have an impact on the diagnostic problems of the sick or could be a valuable resource in emergency medical care. For example, it is estimated that 50 percent of those who die of a coronary could be saved if they had been transported to an intensive care unit in time and the necessary information and procedures received.

5. Skylab experiments are extremely interesting and offer the potential for a variety of breakthroughs such as improved vaccine production techniques due to zero gravity effects.

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This brings us to three questions:

1. *WHAT EFFECT WILL THIS HAVE ON OUR MATHEMATICS EDUCATION PROGRAM?*
2. *WHAT MATHEMATICS SHOULD WE TEACH?*
3. *WHAT IS THE BEST PROGRAM FOR TEACHING THE NECESSARY MATHEMATICS?*

We can be sure that mathematics will continue to play a very important role in our society; therefore, we should provide a program that will help every student to develop the necessary mathematical skills for whatever occupation he chooses.

The question of what mathematics should be taught is much more difficult, and I'm not sure that the answer for the schools in Edmonton is the same as the answer for those in Lethbridge or in Whitefish or Idaho Falls.

OBJECTIVES

Just as each new building requires a set of architectural plans reflecting the local physical and terrain conditions, each district should determine the goals and objectives important for their students. Should your maximum efforts be directed toward a program of college preparatory mathematics classes, or does the large majority of your students obtain employment on farms, in stores or in jobs where the basic skills and shortcuts in computing, such as the number of board feet in a stack or the number of acres in a plot of ground, are the most important? It is essential that the teachers in your schools develop the objectives for their classes, but they should use available resources so that they don't have to "plow the same ground" as other groups have already completed. There are several sources available. It is much easier to adapt a list of objectives to your own needs than to start from the beginning.

The School Mathematics Study Group Newsletter No. 38, dated August 1972, contains some very pertinent information and references concerning educational objectives for mathematics. The S.M.S.G. Advisory Board has listed seven principles which they feel are important for those who are developing objectives:

1. Statements of objectives should be hortatory. They should be taken seriously by teachers, curriculum workers, and textbook writers as important and realistic guidelines. They should *not* be expressions of wishful thinking.

2. On the other hand, statements of objectives should be taken as floors, not ceilings. If a teacher or a school can go beyond stated objectives, so much the better.

3. If the statement of a particular objective is to be taken seriously, then the purpose of the objective has to be made clear. Furthermore, a serious, relevant objective must be so clearly characterized as such as to be easily distinguishable from a personal whim.

4. If statement objectives are to be taken seriously, then the objectives must be clearly verifiable and feasible. It is not enough to know that an objective has not been shown to be infeasible. Before it should be advocated, it should have been positively shown to be feasible (and verifiable).

5. To be consonant with the above, we believe that all statements of mathematics educational objectives should be put in terms of student behavior. (The one exception is that we advocate a particular pedagogical objective: *Teach understanding of a mathematical process before developing skill in the process.* We believe that there is enough empirical evidence in favor of this to make it a realistic objective.)

6. Also, to be in conformance with point 4., we advocate, at present, no affective objectives. There is no evidence available to show that attitudes toward mathematics can be manipulated; consequently, such objectives are not, at present, feasible.

7. None of the above should be taken as suggesting that we ignore goals which are, at the moment, not feasible or not verifiable. Indeed, such goals indicate the most important areas in which to concentrate our future research efforts.

MATHEMATICS PROGRAMS

Once the objectives have been developed, the appropriate instructional materials and media can be selected. There is a variety of good mathematics programs available. There is also the technology and media available to teach practically any concept we desire. At a recent educational media conference I observed a demonstration involving six slide projectors and two 16 mm movie projectors operating in a synchronated display. That was very effective. Another demonstration involved the use of 12 slide projectors operating simultaneously. It is not feasible to have systems like that in too many schools, but it is reasonable to expect the teachers to be proficient with the available equipment and materials and to use them effectively to accomplish the desired goals and objectives.

There are other problems related to materials and hardware which help to prevent the fullest blossoming of educational technology. These were pointed out by Congressman Orval Hansen at the Annual Meeting of the Association for Educational Communications and Technology in Las Vegas:

1. Educators must learn to describe their needs with greater precision.

2. Educators face a serious information gap when making purchases because of inadequate product assessment and consumer information.
3. Rapid technological changes make equipment obsolete too quickly.

These problems are closely related to the need for development of local goals and objectives and assessing the needs of the students. When that has been accomplished, it is much easier to evaluate the materials and media available. The fact that equipment becomes obsolete so rapidly emphasizes the importance of the judicious selection of appropriate materials to help teachers teach the stated objectives. Finances are not adequate to be able to afford the luxury of purchasing some media or materials solely because they are attractive or have limited applications.

After the educational specifications and objectives have been identified, programs can be developed to accomplish those objectives. However, this can still be a difficult task because of the different views and backgrounds of people. It has been said that we see things and perceive them not as they are, but rather as we interpret them to be. This was emphasized at a recent Conference on Contemporary Issues and Problems in Mathematics held at Temple University. Participants at the conference were unable to generate an acceptable definition for the target population. Terms such as "slow learner", "low achiever", "under-achiever", and "general mathematics student" were used synonymously. Apparently the majority of the conferees "lumped" all students who were not in the college preparatory programs into the "same bag".

Participants of the afore-mentioned conference were in agreement that the non-college-bound student is programmatically short-changed, and that all too often the offerings become a "take what's left over" program composed of "bits and pieces" from other courses centered around the computational skills. They felt that a lot of effort had been devoted to the development of programs for the gifted and slow learners while the middle track had been neglected.

If an accurate needs assessment has been completed and the goals and objectives developed are appropriate for your target population, it is anticipated that gaps such as the one mentioned above would not be present. Hopefully the needs of all the students would be met.

The selection and development of the best program to accomplish the objectives is a real challenge. There are many different types of programs involving "individualized instruction, mathematics laboratories, teaching by discovery, the inquiry approach, computer-assisted instruction, and programmed learning". Different things are meant by different people as they use these terms. There is also wide variation in the degree of involvement in the programs. Certainly the interest and training of your staff and the physical resources available play key roles in determining the most appropriate program.

PROGRAM AT IDAHO FALLS

I would like to review with you the program which we developed for our

district. Perhaps you will find one or two ideas useful to you. Idaho Falls is a district with about 10,000 students and has two high schools. There are approximately 2,300 students in Grades X through XII. One school is very traditional, while the other operates on a modular schedule.

As we considered ways in which to improve the mathematics curriculum, it was decided that the program should be consistent with the following:

1. Responsibilities of the schools to the community.
2. Responsibilities of the community to the schools.
3. What are the common concerns and interests of the students?
4. How do the students differ in interests and abilities? Will the program provide for these differences?
5. Will the program prepare students for the changes occurring in society?

The major goals were:

- to provide facilities for more individualized instruction in mathematics by the use of a mathematics resource center;
- to increase the motivation and problem-solving ability of low-achieving students by the use of a variety of media and instructional materials.

It was desired to develop a program that would provide for individualized instruction and independent study without resorting to the preparation of a large number of packets. We also wanted to retain some of the traditional classroom instruction because some students just do not have the self-discipline or ability to do well on independent study. They need the constant reinforcement of daily discussions and assignments.

It was decided to establish a mathematics resource center at one of the high schools and staff the center with a full-time master teacher. This was accomplished through the assistance of a Title III ESEA grant. The students who wish to do so can take their mathematics classes from the resource center teacher on an independent study basis. The teacher is available at any time for consultation, help and encouragement. The other students take their mathematics classes in the traditional manner. It is possible for students to transfer at any time from one program to the other so that it has the added advantage of providing a choice of programs to the students. It has not been uncommon for a few students to transfer from one program to the other two or three times before they feel they are in the program best suited for their needs and interests. It has been found that even highly motivated students on independent study benefit from discussing certain concepts. For that reason, small group seminars are held periodically where students can discuss important points and thus obtain a broader understanding of the concepts.

In order to make the independent study program as effective as possible, learning objectives are written for the courses. Supplementary references and suggested assignments keyed to the textbooks are included in the objectives, allowing students to proceed with a minimum amount of direction from the instructor. The teacher is thus in a position to devote most of his time helping students who need assistance.

Individual conferences are held with each student at the beginning of

each grading period. The student lists the number of units he will try to complete and the average test scores during that grading period. At the end of the period, the teacher reviews the student's achievement with him and makes any appropriate suggestions or comments. It is not uncommon for students to complete two years of work in one year and score outstanding grades on the chapter and unit tests. These students have also made outstanding scores on standardized tests, national mathematics contests, and have been very successful in college mathematics courses.

Included in the resources center is a variety of mathematical games, laboratory activities, computing devices, reference materials and a small computer. The student spends whatever available time he desires in the resource center, but is not required to be there unless he has a conference scheduled with the teacher or is not maintaining a satisfactory achievement record.

Most of the general mathematics students do not work on independent study. However, the teacher uses the materials in the resource center to provide a variety of learning experiences for these students. Short units designed to help them improve their computational skills and problem-solving ability are used rather than a single textbook.

The program has had a dramatic impact on the mathematics program in our district. In 1967-68 (the year just prior to starting the program), the following courses were available at Skyline High School:

General Math	Algebra I
Geometry	Algebra II
Trigonometry*	Solid Geometry*
Math Analysis*	Introduction to Calculus*

The 1968-69 school year was the first year in which the resource room and independent study program were available. The mathematics curriculum was expanded to include the following:

Basic & Business Math	Survey of Math
Algebra I	Algebra II
Geometry	Algebra III*
Trigonometry*	Math Analysis*
Introduction to Calculus*	Computer-oriented Math
Calculus I*	Calculus II*
Machine Language Programing	

In 1970-71, the curriculum was further expanded, without an increase in staff, and included the following courses:

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*semester courses

Basic & Business Math	Survey of Math
Algebra I	Algebra II
Geometry	Algebra III*
Trigonometry*	Functional Analysis*
Analytic Geometry*	Probability and Statistics*
Linear Algebra*	Algebraic Systems*
Calculus I*	Calculus II*
Calculus III*	Computer-oriented Math
Computer Systems and Machine Language	

All of the courses, except calculus, are available on independent study. The other courses are taught in the regular classroom or independent study. It is felt that students in calculus need the additional discussion time periodically.

The number of students enrolled in mathematics classes has increased significantly. Following is a summary of the increase at Skyline High School:

	1967-68	1969-70	1970-71	% Increase
Total number of students at Skyline	1371	1391	1306	4 (decrease)
Number of mathematics classes available	23	27	33	43
Number of students enrolled	550	750	780	42
Number of students on independent study	0	36	120	
Number of basic mathematics classes	1	2	2	100
Number of students in basic mathematics classes	20	30	32	56
Number of students in advanced classes (above Algebra II)	100	147	160	60
Number of students enrolled in two or more mathematics classes	0	10	27	
Number of students enrolled in three mathematics classes	0	0	10	
Number of students involved in computer programming	0	22	35	

*semester courses

The number of classes and enrollment remained approximately the same in 1971-72. There was a slight reduction last year and again this year. However, there are some unique reasons for this.

The program has had a significant impact on the mathematics curriculum at Idaho Falls High School also. During the second year of the program, many Idaho Falls High School patrons wanted to know why their students could not have similar opportunities. There were not sufficient funds in the Title III Project to provide the necessary materials, so the patrons contacted a local company and requested their help. The company agreed to buy a computer for the center if the district would provide the remaining items. This was done and I assumed the position of the resource center teacher. It was the most interesting and enjoyable year I have spent in education.

The Title III Project terminated at the end of the 1970-71 school year, but the program has continued. In fact, there is presently more activity in the traditional high school program than at Skyline. The facilities have been expanded and more teachers are involved in the program.

It has been clearly demonstrated in the development and maintenance of this program that the personnel is the key to success. Except in very unusual situations, the following is very true: *IT'S NOT HOW MUCH YOU KNOW, IT'S HOW MUCH YOU CARE!*

Another very beneficial spin-off has occurred as a result of the project. In 1968, Skyline High School had a small (PDP 8/S) computer. In 1970, Idaho Falls High School obtained a small (PDP 8/I) computer. The district has now secured a PDP II which is capable of doing the district accounting functions and performing instruction activities. As a result, each high school has a small computer and two remote terminals available for use by the students. This has been accomplished for approximately the same cost as was involved when a local service bureau performed the accounting activities.

The students have benefitted in many ways from the program. The benefits include:

1. a feeling on the part of the students that the mathematics teachers really care about them and are looking for better ways to meet their needs (this was indicated by the results of a survey conducted by the students at Skyline);
2. the strengthening of the mathematics curriculum;
3. provision of a center for interesting activities and opportunities for motivation and success activities;
4. greater involvement of the mathematics staff - an extensive in-service program has been conducted to prepare the teachers to meet the challenges of the new project;
5. improved attitude on the students' part toward mathematics;
6. independent study provides a greater opportunity for "one-to-one" discussion and direction between student and teacher;
7. provision of opportunity for a student *to choose* - he can *set his own goals;*

8. students learn to "read" a mathematics textbook and to use the resources available and necessary to solve the problem (one of the real keys to helping students prepare to take their place in a rapidly changing society);
9. increased patron and community involvement.

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TO SUMMARIZE, let's go back to the opening letter. Is it possible for us to teach one of our students that it is more honorable to fail than to cheat, to have faith in his own ideas, to filter all that he hears on a screen of truth, and to have faith in himself? Can we do all of this and struggle with the last few chapters in the text for which we never have time? What a challenge! But it can be met if we will take the time to know and understand our students, find out what their interests and needs are, maybe even visit them and their parents in their homes before a problem develops - just to let them know that we care.

I am sure that most of us are here today because somewhere during our school days there was a teacher who cared enough to touch our hearts and gave us the vision of the great responsibilities and intangible rewards that come from shaping the minds of the young and helping them to discover the truths of the universe.

We can meet the challenge of the '70s, but we have to understand and care about our students, know what our goals are, where we are going, and how we are going to get there.