# What About Drill?

*The difference between developmental teaching and drill will be discussed, along with the necessity for drill, when and how drill should take place, and principles to follow in administering drill.*

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Before I begin to talk about drill, we should look at the purpose of junior high school mathematics. For too long it has been remedial mathematics, getting ready for the next step. It should be an extension of mathematics already learned and a preliminary exploration in the broad area of mathematics. Students of this age are rebellious and do not like mathematics presented as a finished product. Their energy should be directed toward exploration and questioning in mathematics. They should be encouraged and challenged to think about such things as why we divide fractions the way we do, why a negative times a negative is a positive, why we sometimes multiply exponents and at other times add them, and so on. After skills, concepts or principles have been developed, it is essential to carefully develop and plan a program of recurring experiences which will assure that these skills, concepts and principles are not forgotten. I refer to this as drill.

Arlington County, Virginia, has one of the highest levels of adult education achievement of any county in the United States. Teachers there say that their major problem is pupils coming into the ninth and tenth grade not understanding or knowing how to do the basic operations. That is why drill is important.

## *WHAT ABOUT RESEARCH?*

What does research have to say about drill? I would like to review three areas of this research. The first one is the amount of time to be devoted to drill and practice. This research does not differ much from 1914 until now. Researchers in the early part of this century found that periods of about 20 minutes were most effective. Meddleton (1956) cited strong evidence to show that systematic short review work produces higher achievement. In a more recent study (Shipp & Deer, 1960) it was revealed that less than 50 percent of class time should be spent on practice activities since increased achievement resulted when up to 75 percent of the time was spent on developmental activities. This finding has been supported by three or four different pieces of research since that time. So roughly about 20-25 percent of our time, according to the research, ought to be spent on drill practices.

What type of drill produces most effective results? Drill should be constructed to fit a particular purpose. Functional experience is important. Distributive practice is more helpful than concentrated practice. Children should use practice materials on their own difficulty level and progress at their own rate. Varying the type of drill and the use of "frames" were found to be effective by Sandefur (1966).

Where in the sequence of learning mathematics is drill most effective? According to Brownell and Chazal (1935), the time for drill is after effective teaching. This has been generally supported and accepted.

## *WHAT ABOUT DEVELOPMENTAL TEACHING?*

Many teachers use only one instructional strategy, namely the one suggested in the textbook. This is not good. A teacher should acquire alternate instructional strategies. How? - by generating them himself or by seeking procedures already devised by someone else. One way in which this can be done is by looking at other textbooks. Rather than using one textbook for 32 students, use five copies of seven different texts for children. You could work out activity sheets for the various levels of pupils in the class referring them to textbooks, tapes, and so on. Tapes are useful for children who have difficulty in reading the texts.

Individualized instruction can take place with 30 students, or with eight, or only one. We must not necessarily have a one-to-one ratio in all individualized instruction, but we should attempt it.

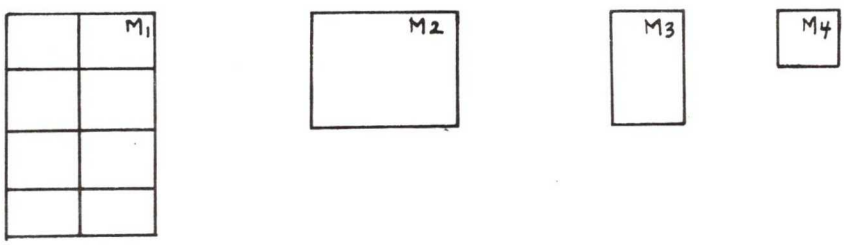
We also have to look at the prerequisites for learning the concepts we try to teach at the junior high level. Often we do not do this. We need to find out if our pupils have the proper background; if they do not, we need to find some way of providing for it in our strategy.

One strategy that has helped me is making copies of students' worksheets and test papers, particularly of those in which many mistakes were made. Last

year I placed copy machines in several classrooms. Teachers made copies of the pupils' work sheets so that I could look at their error patterns. If you keep a record of the error patterns your pupils make, you might be able to devise better developmental teaching. Some research findings indicate that in Grade VII basic properties of addition were not clearly understood, the distributive property apparently being the most difficult. If there is one property that we should get across in pre-high school mathematics, it is the distributive property. It can be of tremendous value. It has been found that only three of ten fraction principles were known in Grade V, while four were known in Grade VI. This means that we must still do a lot of developmental teaching and drill in the basic operations in whole and rational numbers at the junior high school level.

The type of developmental learning I would like to see take place with all students is that in which the student has his own package of materials such as the package partially illustrated in Figure 1. In this package are colored

Figure 1




acetate sheets labeled $M_2$, $M_3$ and $M_4$ ($M_2$ is ½ the size of $M_1$, $M_3$ is ½ the size of $M_2$, $M_4$ is ½ the size of $M_3$) and a plain sheet of paper labeled $M_1$ that has been divided into eight equal sections. The activity sheet will ask the students to use these sheets to find answers to the following problems: ½ times 1; ½ times ½; ½ times ¼. Just let them play around with these for a while. The next thing I ask them to do is to find the answer to these three problems. Soon many of the students come up with the correct answers by proper overlapping of the sheets. In drill work it is important that we reinforce learning immediately. (I prefer giving back papers to students immediately to giving them a lot of things to do.)

In my activity sheets I like to move from the complex to the simple so that the good student will not waste time reading all of the other questions which I put down for the weaker student. What about the bright student? Every time I make an activity sheet, I develop three. The first one is a basic activity for all students who are going to be functional citizens, the second is for the average students, and the third is for the accelerated students in the class. The wording on these is quite different.

If teaching takes place so that concepts are meaningful to pupils, then the amount of drill needed might be reduced.

## *WHAT ABOUT DRILL?*

Drill should be relevant and well motivated. For example, I have used some cardboard index paper that simulates a sleeve and piston of a gasoline engine. The student is told that all he has to do is roll the piece of index paper until the four holes of the paper match. He thinks of this as a sleeve for the piston of an engine. We have a piston that can be made to go into the sleeve. Then we proceed to develop exercises related to this. Some of the sleeves have a radius of one inch so that most of the pupils can work with it. I give the better students actually the specifications of an automobile and have them work with the real thing. With this, they can see the need for fractions and decimals. We can give them drill this way without their actually thinking they are being drilled.

Figure 2 illustrates a gimmick I like which camouflages drill. This is necessary for some students. It can be used at the grade three level or at the high school level. Figure 3 shows how it can be used at the high school level.

Figure 2

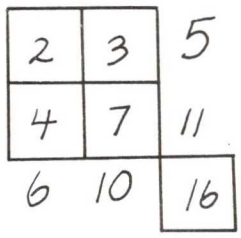
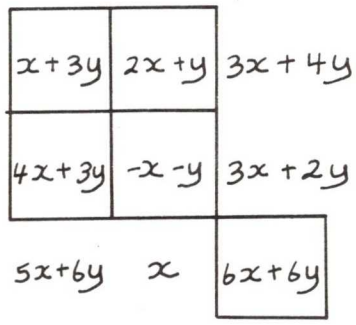



Figure 3



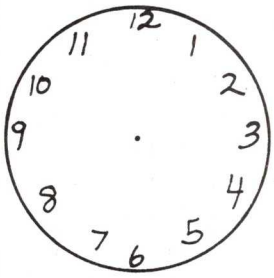

In junior high school, we can use fractions or decimals instead. We can also leave out some of the factors, put in the answer, and let the student find the other factors. You can also use this with multiplication. Your better students might want to prove that this does work.

Another source of good exercises is a world book of records. There are many highly motivational and relevant facts in such a book. By using such things, you can do a tremendous amount of drill work which is not a repetition of things students have had in the past.

Similarly, *Popular Science* is a source of an amazing number of exercises at various interest levels. Let the students make up their own exercises and pass them around. I set up four or five stations, order the material according to difficulty, and have the students go to these tables according to their ability.

I have also made good use of catalogues. I have a catalogue of 100,000 car parts which is highly motivational and extremely relevant, particularly to boys who are interested in automobiles. You might also collect mathematical puzzles out of the magazines to which you have access. One of the best I have seen relates to the watch face.

Figure 4




Can you divide the watch face with 2 straight lines so that the sums of the numbers in each part are equal?

Can you divide the watch face into 6 parts so that each part contains 2 numbers and the 6 sums of 2 numbers are equal?

This gives drill in logical thinking and in addition. Sometimes the child who, in your opinion, cannot add very well will come with the answer first.

Research has shown that games and puzzles are great devices to motivate students. You are treading on thin ice when you try to make them competitive. This discourages some of your weaker students and also some of your better students very quickly.

You should let the students know the reason you are doing things. You should tell them in clear and concise language what you want them to learn. The student ought to have some way of evaluating himself so that he knows whether or not he has achieved the things you wanted him to achieve.

How much drill? I say enough. The amount of drill will vary according to students' difficulty with mathematics. Do not give them more than they need. Do not give them problems too difficult for them. One of the worst things we can do is simply assign problems on a certain page to do for homework to all students in the class. At best this will hit a small percentage of the class. Some will be beyond this, others will not be ready. Give them enough drill to satisfy their needs but not too much. This can be determined by giving them self-evaluation sheets, letting them decide when they can do certain examples.

What should be emphasized? We should never forget the aesthetic value of mathematics, but to many pupils the division of fractions is never going to be very useful. For that matter, neither is working with 11's, 17's or 43's. Table 1 contains the results of a survey conducted in the business world.

TABLE 1

FREQUENCY OF USE OF SOME FRACTIONS IN THE BUSINESS WORLD*

| Fraction | Percent frequency of use |
|---|---|
| Halves | 31 |
| Fourths | 36 |
| Eighths | 20 |
| Thirty-seconds | 9 |
| Sixteenths | 1 |
| All others | 3 |

*_Mathematics Newsletter_, Department of Public Instruction, Raleigh, N.C., Fall 1973.

A survey of Grade VII mathematics books revealed that the fractions ½, ¼, 1/8, 1/16, and 1/32 represented about 15 percent of the fractions considered in these books, all others about 85 percent. We ought to take a look at what we are teaching our students.

We ought to look at the practical uses of mathematics. The other night, I got a check at a restaurant and knew that it must have been added incorrectly because I had estimated how much my bill was going to be. We need to teach pupils to estimate because it is a real help as far as drill is concerned. How much of us actually figure out if our banker has charged us the correct interest when we borrow money? Yet a fair amount of our time is spent around Grade VIII trying to get students to do complicated problems involving interest. This is something they will probably not need again with the invention of the pocket electronic calculator which is going to make a difference in the amount of mathematics needed.

Emphasis should be placed on correctness of response rather than speed. We give drill so that a correct pattern of behavior can be developed. A pupil who practises incorrect behavior, even if he gets his work done quickly, is in trouble. We ought to give students immediate feedback by giving them certain check points. For example, every third problem could have the answer worked out or a way provided for checking.

As much as possible, drill should be self-diagnostic. As the pupil works on the assigned exercises, he should become aware of the behavior which he has not learned. This would imply that he can go back and find answers quickly.

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