THE DEVELOPMENT AND USE OF A VISUAL AID
TO TEACH FRACTIONS

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By
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Approved by:
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CHAPTER I

INTRODUCTION

Theory Underlying The Use of Visual Aids

Today's teachers are constantly striving for more functional and more effective ways of helping children learn. Teachers have come to understand the importance of vital, first-hand and vicarious experiences in the education of children. Most teachers understand that the child is no longer a passive being that remains passive unless stimulated. It is now common knowledge that children are active, dynamic individuals. A study of theories of learning emphasizes the importance of motivation and participation. Motivation simply means that one has to make an effort to learn more effectively. In other words, children will attack a problem with a desire for the solution, if the practical value which lies in the solution can be seen. The child must have a real feeling of need, strong enough to create a desire within him for learning. Participation means one learns by doing. For example, it is very difficult for a child who lives in a crowded apartment building, and who has seldom left the city to understand what happens or how one milks a cow. This problem does not exist for the child who lives on the farm and helps with the milking. Participation is rooted in
experiencing. Yet many teachers are troubled with the problem of children forgetting what has already been taught. Teachers continue to search for the answer of how to make what children learn "stick."

The answer to this problem of retention lies in making what is learned real for the learner. The answer also lies in making learning part of living. Weaver puts it this way:

A learning is the result of sensory experiences whether they be touch, taste, smell, hearing or seeing. Sensory experiences are not only necessary to complete comprehension, but they are the key to students' mental activity and future learning. All of us like to get our hands on novel and interesting objects because we crave first-hand experience. In short the opportunity to touch, feel, handle or operate a model or other objects under discussion, involves types of manipulatory activity that represents participation or self activity which is so necessary for learning and always interesting.¹

Lemon puts it in easy-to-understand terms when he says that:

Teaching is effective only when the child reacts with understanding to the various stimuli provided during the process. Early in life the child observes, listens, handles, and explores. His interest and activities are challenged by the concrete at home and in school. Any kind of realia command his attention. As he progresses in learning we observe that interest is a vital factor to his success. Correct first impressions are imperative. An analysis of memory and its' elements revealed that retention, recollection and recognition

¹Gilbert G. Weaver, Visual Aids: Their Construction and Use. p. 4.
depend upon vividness of impression-difficult of attainment through words, but easy and positive through visual aids.\(^2\)

The experiences which are direct, first-hand experiences are the experiences which will probably affect an individual most deeply, and thus be most completely learned. But it is never possible, nor practical, for all experiences to be direct or first-hand. It would have been both impossible and impractical for all of the people of the United States to have been present at an atom bomb test explosion. In lieu of the direct experience many, indeed most, of the people were content to be educated about such matters by watching it over their television screen, or by reading about them in newspapers or magazines. Those who viewed the explosion on television will probably remember it more vividly than those who only read about it. It is not the writer's purpose to minimize the importance of reading, but rather to point out that direct experience is necessary in understanding processes, in forming generalizations, and in making reading itself most meaningful. In the absence of rich, direct experience, teachers must turn to visual aids to help them in providing functional learning experiences for children.

Visual aids, like milk and vegetables, provide vitamins for "scholastic babes." Visual aids promote learning in that they serve to make school experiences more natural,

more realistic, more interesting, more psychological. 3

The values of visual aids lie in that:

1. Pupils may retain more of what is taught.
2. They may produce a sense of reality.
3. Material is probably presented more accurately.
4. Interest of the learner may be increased.
5. Learning may be more extensive and faster.
6. Time may be saved.
7. They may help to hold the attention of the learner.
8. They may help the learner understand relationships.
9. They may help the learner form images.

Some visual aids, of course, will be more valuable than will others for specific purposes. Dale illustrates, in his cone of experience, that there seems to be an order from direct experience to more abstract interpretations of experience. According to Dale the purpose of the cone is to help explain the relationship of the various types of sensory materials, as they move from the direct experience to the more abstract means of learning. The cone as a whole sub-divides into three major groups:

1. Direct experiences
2. Contrived experiences
3. Dramatic participation
4. Demonstrations
5. Field trips
6. Exhibits
7. Motion Pictures
8. Radio, Recordings, Still Pictures

Involve doing in order of decreasing directness
Involve observing in order of decreasing directness

9. Visual symbols involve symbolizing in order of increasing abstractness.

Dale does not mean that direct experience is always "better" than indirect experience. Experiencing a great dynamo in action might have less meaning than a model of a dynamo. It is not the purpose of the writer to minimize the usefulness of other forms of visual materials by referring to direct and contrived experiences quite frequently. The numerous references are made only because the subject of this paper, in the writer's opinion, can be classified as a contrived experience. All of the visual aids serve desirable ends if used efficiently and effectively. Indeed, in some cases, those listed near the top of the cone may even be of greater value than those at the bottom.

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We simplify the teaching process by inventing a plan or device which has many of the advantages of direct experience without certain of its disadvantages. We "edit reality". Now to edit is to re-arrange, to strike out something here and add something there, in order to make meaning clearer. We try not to sacrifice the quality of directly experiencing. These contrivances involve hearing, seeing, handling, and other sensations. We merely remove the complicating and distracting elements, so that the student can get to the core of the matter. 

Many visual aids of great importance to teaching fall into the category of "contrived experience." If a child wants to learn how a steam engine works, little value could be gained by showing him an actual steam engine, compared to the value he would receive if he developed a model whose principles were the same. In the model, the major theories and principles would be present but the complexity and technical aspects would be left out. Showing a child an old-fashioned well and pump might not be as valuable as showing him a model of the well and pump, and how the pump extends into the earth. In other words, "for certain understandings, an edited version of reality can be better than the unedited reality itself."

In developing a visual aid for use in the classroom, a teacher should realize that visual aids are not and should not be regarded as an end to be achieved in the educative process. In the final analysis, a visual aid is only a means

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5 Ibid., p. 39.
6 Ibid., p. 41.
to an end. Having the means does not necessarily assure their proper use. Possessing visual material will not help a teacher teach well if his fundamental ideas about teaching are disorganized or based on outmoded premises. However, if a teacher has a sound understanding of good teaching, then he will recognize and use all teaching materials as media--as agencies which help the child to gain knowledge. The teacher must have a sense of proportion. He must be clear about his purposes and values. For if the process is confused with the product (effective learning), visual materials may actually become a stumbling block in the curriculum.

A visual aid is any specifically prepared drawing, illustration, model, motion picture, film strip, or other device that will expedit learning through the sense of vision.\(^7\) Like anything else, its usefulness depends upon how it is used. A good tool in the hands of a skilled workman insures a satisfactory product.

**The Problem**

As the writer worked with children in the fifth and sixth grades, it was observed that fractions presented a great deal of difficulty to these children. There are many differing views regarding the teaching of fractions in these grades. But in most school systems in Ohio, learning to use fractions constitutes a very large part of the curriculum experiences in mathematics in the fifth and sixth grades.

\(^7\)Ibid., p. 4.
It is not the purpose of this paper to determine whether fractions should or should not be taught in the elementary school. Nor is its purpose one of determining the extent to which they should be taught. Rather, it is the writer's purpose to see what can be done to make the learning of the fundamental processes in fractions more meaningful to children.

This paper is devoted to a report of the construction and use of a visual aid which was designed to help make fractions more meaningful for children. This paper is a report concerning one teaching aid which was used by one teacher in meeting the problems which fractions presented to the children in his room.

A child brings to school from life situations experiences involving some fractions. In the writer's opinion very few children in the first grade would be confused about half an apple, or half a candy bar. Many children know that a half-dollar is equal to fifty cents, or that a quarter of a dollar is twenty-five cents, and certainly those familiar with the circus should know that one tenth of a dollar is a dime. However, it is evident that only a few, if any, children know that five tenths are equal to one half or two quarters. Very few children would be concerned about adding a half-dollar and a quarter. And to ask them to add one half and one fourth is another matter.

In the writer's opinion, many teachers feel that the fundamentals of fractions can be taught by providing
mechanical rules. But unless specific experiences are provided, there is probably little chance for these rules to stick. Children ought to be able to see, for example, that one half is the same as two fourths, or that two sixths and one third are the same, before being confronted with the verbal rule. It is not the writer's purpose to denounce the rules, but rather to infer that rules may be useless unless the children understand the sense of the rule through many concrete examples.

In order for children to draw conclusions, they must have specific experiences. In the past some teachers have used paper plates, paper, the blackboard, or have even purchased pies or apples to make fractions more meaningful. These media are probably good, however to the writer it seems these concrete objects also present a few difficulties. Children might find it difficult to divide a paper plate or a piece of paper for fractions such as one third, one sixth, one fifth, as well as many others. It might be difficult for children to compare fractions which are on two separate plates. In working with these media, children might need scissors, or other cutting devices, and time would be used in passing these things out which might better be used developing basic insights and concepts. The writer is not attempting to list all of the difficulties which might be involved in working with these media. He is only trying to point out that a visual aid might be made to do the things which other devices do, and yet be more practical, meaningful,
and useful in helping children understand fractions.

In making a practical visual aid to help children understand fractions, it was felt that the visual aid should meet certain criteria.

The visual aid must be:
1. Sturdy, to prevent breakdown.
2. Constructed so that there is movement of the parts.
3. Constructed so that the children can handle, touch, and manipulate it.
4. Large enough to be seen at a distance.
5. Accurate in all its potential concepts.
6. Practical, so that anyone could use it.
7. Inexpensive, so that any teacher might have it.
8. Colorful, to aid learning and to hold attention.
9. Attractive, to stimulate interest.

In the writer's opinion the following is a list of objectives which might be realized by using the visual aid.

It should help children learn:
1. What a fraction is.
2. That each fractional part looks like, in relation to other fractional parts, as a visualization of mathematical relationships.
3. How one fraction may be equal to two or more other fractional parts.
4. How the four process involved in fractions operate.

The next chapter will be concerned with the construction of the visual aid; the problems involved in construction;
and how the criteria listed in this portion of the paper affected the construction.
CHAPTER II

CONSTRUCTION OF THE VISUAL AID

Criteria For Construction

In the previous chapter it was stated that, before any construction could be undertaken, certain criteria must be set up and met. The criteria were listed. The writer will now try to show how each criterion previously listed affected the construction of this visual aid, in the category of "contrived experience."

1. Sturdy to prevent breakdown. There are several good reasons why this criterion is important. First of all, if something is going to be built, it should be built to stand the test of use in time. In other words, a visual aid of this sort should be so built that it could be used from one year to the next, not for just a few months.

Secondly, a good teacher shares whatever material he has with other teachers. Some other teacher in some other grade may find this visual aid useful in his teaching. It should be so constructed that it could be taken from one room to the next without fear of it being damaged or broken. Many times children want to do jobs like this for their teachers; therefore, a certain number of accidents to the visual aid must be expected. On the other hand, since this visual aid will be carried about within the classroom, as well as without,
it should not be so heavy and cumbersome to tax a child's strength. Construction, then, should not only be sturdy in order to meet a normal amount of handling and accidents, but it should also be light enough in weight for ease of movement.

A third point to be made is that one of the values of a visual aid is its potentialities for using the sense of touch to help children learn. During the construction of the visual aid being discussed this fact was kept in mind. Since children will use the visual aid by touching it, and moving the parts about, it must be so built that it will facilitate such handling by the children. Many times children are unintentionally careless, or do not realize the amount of force which they exert. Such considerations must be recognized in constructing the visual aid.

2. Constructed so that there is movement of the parts.

The more senses the teacher can bring into the learning situation, the greater the amount of learning achieved by boys and girls. Motion pictures frequently are of greater value to learning than still pictures. Drawing a picture of a pie on the board, and dividing it with chalk lines, has less value than having a real pie, cutting it with a knife, and removing the pieces. Movement is important to learning, in that it stimulates interest and thinking. Therefore, if the parts of this visual aid have movement, children will be more attracted to it, because through action relationships can be demonstrated.

Movement is necessary to this visual aid if children are to see the difference between one fraction and another.
They must see the fractions in contrast and in comparison to one another. This is also true if children are to see how many of one fractional part will equal other fractional parts. To help children see this, it was the opinion of the writer that the visual aid should be so constructed that the fractional part could be slid underneath, or over each other, so that the contrast or comparison might be made. Anything stationary or firmly fastened would not give a true picture, because the person making the comparison would have to work with multiple materials and see relationships therefrom, which might be more confusing than helpful. In this visual aid, such confusion is minimized, since all fractional relationships are apparent through manipulation and study of a single, easily controlled device.

3. Constructed so that children can handle, touch, and work with it. The importance of bringing into the learning situation as many of the senses as possible has already been discussed. Children learn by doing. Therefore, this visual aid should be simple enough, and so constructed that any child could handle, touch, examine, experiment and thus comprehend it. The more the child can bring his senses into contact with the contrived experience, the greater the learning will be. The visual aid under discussion must utilize the sense of seeing, as well as the sense of touch.

4. Large enough to be seen at a distance. The writer feels that there are two ways in which the visual aid can be used. First, it can be used by the children. Secondly, the
teacher can use it with the children in specific learning situations. If the teacher is to use the visual aid to make a point, it must be large enough to be seen by the group at a distance. Not only must the child sitting near by be able to distinguish the size of each fraction, but so also must the child sitting in the farthest part be able to see and thus understand the specific concept or information being presented.

5. **Accurate.** The reason for this criterion is obvious. In order to receive a true picture of anything, the observer must receive an accurate picture of the objects under consideration. Therefore, if a child is to receive a true picture of what a fraction is, in comparison or contrast with another, the fraction must be a true representation of the part in relation to the whole.

6. **Practical and inexpensive.** It is indeed discouraging to find that when a person buys something, it might be rendered useless if a minor part breaks. With this thought in mind, the writer, felt that if any part of the visual aid breaks or is damaged, it should not be difficult to repair.

It goes without saying that expense of articles used in the classroom give teachers, as well as administrators, a great deal of concern. It was felt by the writer that the visual aid should not incur an expense too great for the teacher, or for the school to meet. It was also felt by the writer that, wherever possible, the visual aid should be constructed by the school personnel, or could be given to
some high school group to construct as socially useful work.

7. Colorful and attractive. Children are much happier in a classroom which is colorful and attractive. Teachers are indeed aware of the value of teaching in a modern building. In looking over books, one of the items which a teacher looks for is the kind of pictures which the book has. A book may be bought because a teacher feels that the pictures will increase the child's interest.

The same kind of thinking should exist in examining classroom materials. The attractiveness of the object is important, but the writer feels that wherever possible, the color should also be used to help the child learn and develop in his thinking.

The Actual Construction

Sturdy, to prevent breakdown. In discussing this topic previously, it was brought out that a visual aid must be durable, have strength, and be easily carried about. The material which best meets all of these demands so far as the frame is concerned, is wood.

The construction of the frame was carried about in this manner. It was decided that the size of the frame should be about forty-one inches long, and thirty inches high. The wood used was pine. Each piece used was two inches wide, and three fourths of an inch thick.

The frame was made in the shape of a rectangle. In order to give strength to the frame, a joint was made so that the pieces making the length of the frame would fit into
a slot, cut into each end of the pieces used for the sides. Screws were used to fasten the pieces together. Three screws were put into each joint, with two of the screws being on the face of the frame, and the third screw on the back.

If, during the use of the visual aid, any one of the sides of the frame might break, all that would need be done to repair the damage would be to remove the screws and replace the broken piece.

The materials which were used to represent the fractional parts were pieces of white pine wood, one inch square and twenty-four inches long. Each piece was ripped down the center, and a groove one eighth of an inch deep was taken out of each piece. The two pieces were then glued back together again. The effect of this was to have a piece of wood twenty-four inches long, and one inch square, with a one fourth inch groove out of the center.

The next problem which arose was puzzling. At the onset, the writer felt that wooden dowls could be used to support the pieces representing the fractional parts. However, to the writer's knowledge, and after an inquiry was made at several lumber yards, no company stocks dowls longer than thirty inches. At first the solution to this seemed to be to shorten the frame and reduce the size of the pieces so that wooden dowls could be used. However, after experimenting, it was soon discovered that wooden dowls sagged when any weight was put on them. The writer also surmised that wire would do much the same thing.
MATERIAL USED

White pine wood - two pieces - for length

3/8" diameter

Steel rods - twelve pieces - for supports

White pine wood - twelve pieces - used to represent fractional parts

FIGURE 2

PIECES NECESSARY FOR CONSTRUCTION
After considerable inquiry, the solution reached by the writer was, that a steel rod, one fourth of an inch round, and threaded on the end would work satisfactorily. Obtaining the steel rods presented another problem. Finally the writer found a company willing to donate a sufficient number of steel rods to make the necessary number of supports.

In order to put the steel rods in the frame, holes had to be drilled into the side pieces. The holes were spaced two inches apart. This would allow a clearance of one half inch between the pieces representing the fractional part. The diameter of the hole drilled into the side pieces was three eighths of an inch. This would allow the one fourth inch rod to enter easily.

After the holes were drilled, the steel rods were threaded, so that a nut could be placed on the end to hold the rods securely in place.

Constructed so that there is movement of the parts. It has already been mentioned that the pieces representing the fractional parts are pieces twenty-four inches long, and one inch square. Through each piece a hole has been made equal to one fourth of an inch. This was done to let the piece slide back and forth across the rod easily and rhythmically.

Constructed so that children can handle, touch, and work with it. The frame will certainly be strong enough to let children handle it without fear of breakage. The steel rods will not bend easily, nor will the pieces representing
the fractional parts break or come apart. This means that with reasonable care any child will be able to examine, work, or even play with the visual aid without repression.

Large enough to be seen at a distance. The pieces representing the fractional parts are basically involved at this point since it is these pieces which are to be examined by the children. It has been already noted that the piece representing the whole on the frame, is twenty-four inches in length. This would mean that one twelfth would be two inches long. A piece of wood two inches in length could be seen by anyone with normal vision, at a distance of thirty feet. Twelfths would be the smallest fractional part on this visual aid.

Accurate. In determining which fractions should be represented on the visual aid, the writer was aware that certain fractions are used to a much greater extent than others; these are the fractions one half, one third, and one fourth. But the writer felt that from the standpoint of comparison, and also from the standpoint of showing differences in size, all of the fractions from one half to one twelfth should be represented.

It is at this point that accuracy plays a very important part. It has been mentioned that each piece representing the fractional part is twenty-four inches long. This would mean that the piece representing the whole would be twenty-four inches long. Halves would be shown by two pieces, each twelve inches long. The rest of the fractional parts and
their measurements are as follows:

Thirds -- three pieces, each eight inches long.

Fourths -- four pieces, each six inches long.

Fifths -- five pieces, each four and four fifths inches long.

Sixths -- six pieces, each four inches long.

Sevenths -- seven pieces, each three and four sevenths inches long.

Eighths -- eight pieces, each three inches long.

Ninths -- nine pieces, each two and two thirds inches long.

Tenths -- ten pieces, each two and two fifths inches long.

Elevenths -- eleven pieces, each two and one twelfth inches long.

Twelfths -- twelve pieces, each two inches long.

It can be easily understood that if the pieces are not cut accurately, then the child will not get a true picture of the fractional part in proportion to the other fractional part or parts.

Practical and inexpensive. It is the writer's opinion that the visual aid is practical from two standpoints. First of all, any one or all of the parts could be replaced. If a side of the frame becomes cracked, another can be substituted. If one of the steel rods become bent, its replacement is simple. If one or more of the pieces representing a fractional part becomes worn or broken, it too can be readily replaced.
Secondly, the writer feels that the visual aid is practical in that very few tools are necessary for its construction, or repair. It has been mentioned that perhaps high schools could produce them as a project. The most difficult job would be the one involving the ripping of the pieces representing the fractional parts, and grooving them out. However, this can be satisfactorily accomplished with an electric power saw.

The writer realizes that expense is an important aspect in the construction of any teaching tool. In constructing the visual aid under discussion, much of the material was given to the writer. However, to give some idea of what the cost might be, the following approximation is presented:

<table>
<thead>
<tr>
<th>No.</th>
<th>MATERIAL</th>
<th>COST</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>13 ft.</td>
<td>white pine wood</td>
<td>@ 14¢</td>
<td>$1.82</td>
</tr>
<tr>
<td>12</td>
<td>steel rods</td>
<td>@ 15¢</td>
<td>1.80</td>
</tr>
<tr>
<td>12 pieces 1&quot; sq. grooved white pine</td>
<td>@ 15¢</td>
<td>1.80</td>
<td></td>
</tr>
<tr>
<td>3 sheets</td>
<td>sandpaper</td>
<td>@ 3¢</td>
<td>0.09</td>
</tr>
<tr>
<td></td>
<td>paint</td>
<td></td>
<td>1.00</td>
</tr>
<tr>
<td></td>
<td>varnish</td>
<td></td>
<td>0.50</td>
</tr>
<tr>
<td>15</td>
<td>screws</td>
<td></td>
<td>0.15</td>
</tr>
<tr>
<td>24</td>
<td>½&quot; nuts</td>
<td></td>
<td>0.20</td>
</tr>
</tbody>
</table>

| TOTAL COST | $7.36 |

This total cost represents a minimum, and does not take into consideration pay for work done by the constructor. It is the opinion of the writer that the cost of construction could be much less if material on hand were used, or if the
project was a school project. But the total cost could be
even more, if a teacher had to have a private concern do the
work for him. At any rate, from the standpoint of use, it
is the opinion of the writer that the visual aid is worth
the small cost and time expended.

Colorful and attractive. It has already been men-
tioned that color and attractiveness are vital in creating
interest in the child. Therefore, the colors used in painting
the visual aid seemed to present no problem.

However, in reflecting upon this aspect of the con-
struction of the visual aid, the writer concluded that color,
if possible, should be used to help the child learn. How,
then, could this be accomplished?

After much thought and experimentation the following
conclusions were accepted by the writer:

1. A primary color should be used for one
   half and one third, since these are the
two largest fractions.

2. All fractions which can be converted to
   one half, and vice versa, should be
   painted the same color as the pieces
   representing the half.

3. All fractions which can be converted to
   one third, and vice versa, should be
   painted the same color as the pieces
   representing the third.

4. Any fraction which can be converted to
   both halves and thirds should be painted
   with two sides corresponding to the color
   of the half, and the other two sides
   corresponding to the color of the third.

5. The whole should be made of a color
   obtained by mixing the colors used for
   half and third.
6. The frame should be left a natural color, and just varnished or waxed.

7. Any fraction which cannot be converted to another fraction should have its own peculiar color. If a fraction can be converted to another fraction, other than one half or one third, then half of its color should be the same as the other fraction.

To help make this clear and to put it simply, let us use an example. If a child was concerned with a fraction whose color is red, then the child should surmise that all of the fractional parts containing red, would in some way work together. If a fraction was painted green and red, then it would work with the fractions painted green, and with the fractions painted red.

The following is a list of the colors used and the reason for using such colors.

1. Halves—to be painted red. Red is a primary color.
2. Thirds—to be painted yellow. Yellow is a primary color.
3. The whole—to be painted orange. Orange is the color obtained when yellow and red are mixed.
4. Fourths—to be painted red. Two fourths are equal to one half. Halves are painted red, therefore fourths should be red also.
5. Fifths—to be painted green. Fifths cannot be converted to thirds or fourths. Therefore, fifths should have a color peculiar to itself.
6. Sixths—to be painted red on two sides, and yellow on two sides. Three sixths are equal to one half.
Two sixths are equal to one third. Therefore, sixths can be converted to both halves and thirds, and should show both colors.

7. Sevenths—to be painted brown. Sevenths cannot be converted to any fraction represented on the visual aid, therefore its color should be different from any of the other fractions.

8. Eighths—to be painted red. Eighths can be converted to fourths and halves, therefore its color should be the same as fourths and halves, or red.

9. Ninths—to be painted yellow. Ninths can be converted to sixths and thirds. However, the largest fraction to which ninths can be converted are thirds. Therefore, its color should be yellow. Yellow is also present in sixths.

10. Tenths—to be painted green on two sides and red on two sides. Tenths can be converted to halves. Five tenths equal one half. Tenths can also be converted to fifths. Two tenths equal one fifth. Therefore, the colors represented should be the color of halves, or red, and the color of fifths, or green.

11. Elevenths—to be painted blue. Elevenths cannot be converted to any fraction on the visual aid. The color blue is not represented, therefore it can be given to the pieces representing elevenths.
12. Twelfths--to be painted red and yellow. Three
twelfths equal one fourth, and six twelfths equal
one half. One fourth and one half are painted
red, therefore, two sides of the pieces repre-
senting twelfths should be painted red. But, two
twelfths equal one sixth and four twelfths equal
one third. Yellow is represented in these
fractions; therefore, the other two sides should
be painted yellow.

In conclusion, the writer's experience in the con-
struction of this visual aid indicates that a useful visual
aid for helping children to comprehend fractions can be made.
The experience of construction has also made the writer
realize that the visual aid is not perfect in all respects.
There are a few aspects which should be improved or changed,
but it is the writer's opinion the changes are of such a
nature that the visual aids function of making fractions more
meaningful to children is not minimized. The need for
improvement was not actually apparent until the visual aid
was used, therefore any recommendations for improvement will
be found in the part of this paper concerned with the use of
the visual aid.
CHAPTER III

THE USE OF THE VISUAL AID

Finding Out What A Fraction Is

After construction was completed the visual aid was brought into the classroom, before school. Nothing was said to the children about the visual aid, but it was put in a place where all of the children could see it.

On the first day there were only a few children who more than noticed the visual aid. Some of the children looked it over, and then passed by. Some of the children twirled the blocks representing the fractions and then went on.

The second day showed a little change. At one time there were quite a few children gathered around the visual aid. The writer noted the following:

1. The children liked to run their fingers down the visual aid, because the pieces would spin. It seemed that the spinning colors attracted them.

2. Some children would slide the pieces back and forth without paying too much attention to the size of the pieces or to the order.

3. Some of the children counted the pieces on the visual aid, and found that there were seventy-eight pieces in all. However, none of them seemed concerned because some of the pieces were of different sizes.
The third day was the day when the most interest was shown. Some of the children asked, "What is this for?" The reply given by the teacher was, in effect, "What do you think it is for?" Most of the children stated that they did not know. Some of the conversation follows.

Child: Is this for arithmetic?
Teacher: Why do you think it is for arithmetic?
Child: Because there are ten on a line. (This particular child was looking at the bar representing tenths.)
Teacher: Are there ten on every line?
Child: No, I don't know what it is for.

This type of conversation was carried on by the children for about two more days, with some of the children sliding pieces over to one side, and some counting the pieces on the frame. One day, when the children were sharing some news, a child stood up and said he knew what the visual aid was for. The conversation which follows is not word for word, nor is it implied that all of the talking was done on one day. Much of the learning took several days. By using the child's conversation it is the writer's purpose to show the steps in the children's thinking process, and to give the reader some indication of the way the children reacted. The word child is used to mean any one of a number of children. Not all of the remarks are listed, but only those which the writer felt were important in advancing the thinking of the children toward better understanding of fractions.
Child:  Mr. M____, I know what that thing is for.
Teacher:  What is it for?
Child:  It is for fractions.
Teacher:  Why do you think it's for fractions?
Child:  Because all of the pieces are of different size.

This evidently was correct, according to most of the children, because there seemed to be nods and smiles, indicating that the children were in agreement with the statement.

Teacher:  How do you mean all of the pieces are of different sizes?  Come up and show the class.

The child went to the visual aid and slid the first piece on each bar over, so that as you looked at the visual aid from top to bottom it was apparent that each piece became smaller.

Teacher:  How does that help you know that it's (the visual aid) for fractions?
Child:  Well, because this is a half.  (The child pointed to the piece representing the half.)

Teacher:  How about the other pieces?
Child:  I don't know about them.

Teacher:  How many agree that we might use this (the visual aid) to help us learn about fractions?

Most of the class thought it could be used in that manner. One child was observed with a very puzzled look on her face. The writer asked the child what was on her mind. This particular child experienced difficulty in many areas, but her answer seemed to indicate good thinking.
Child: Teacher, I don't know what you mean. What are fractions anyway?

In the opinion of the writer this question represented a step forward in the thinking of the children. Up to this point the children talked about fractions, and knew that sometime in the sixth grade they would have to learn about them. None of the children, however, had asked just what a fraction is until the previously mentioned child directly asked the question. It was also the writer's opinion that the answer to the question should come from the children, if possible. The children were asked if they could answer the question.

One child said that a fraction is one half.

Child: I know. A fraction is one half.

Teacher: One half is a fraction, but do we have other fractions?

Child: Yes, there is one fourth, and one third too.

Teacher: But what does one fourth or one third mean? You are right when you say they are fractions. They are examples of fractions. But just what is a fraction? What do we talk about when we talk about fractions?

Child: We talk about pieces.

Teacher: Yes, many fractions are pieces.

Child: Teacher, they are not always pieces. My mother sometimes has to use a third of a cup of milk when she makes ready-mixed cake.

Teacher: Of course, then fractions might be pieces or -----.  

Child: I know. A third of a cup of milk is not a whole cup, so it's a part of a cup. A fraction might be a part
of something.

At this point in the children's thinking the visual aid was formally used for the first time. The interest in fractions had reached a point where the children were asking their older brothers and sisters about them. Many times the children asked the writer when they were going "to start fractions."

In the writer's opinion the children had already learned the basic concept concerning fractions. They had learned what a fraction is, and had generalized that a fraction is a piece or part of something. By examining the visual aid on the first several days the children observed that:

1. Each piece on the visual aid became slightly smaller as you looked from top to bottom.

2. Each bar, from top to bottom is the same size, but increased by one in regard to the number of pieces on each bar. That is, the first bar is one whole piece, the second bar has two pieces, the third three, and so on through twelfths.

The children were becoming aware of fractions when they saw them. For example one child said that while riding on a downtown bus, he noticed a large neon sign which said, "Save from one third to one half." The child wanted to know how much a person would save if he saved one third or one half.

The visual aid was used at this point. The children were asked to look at the first three bars on the visual aid.
FIGURE 3

Each bar on the visual aid represents a fraction, with the exception of the top bar which represents one whole. The fractions are in order of their size with halves first and twelfths on the last bar.
FIGURE 4

This figure shows how each fraction on the visual aid appears in proportion to each other. One whole through one twelfth as represented consecutively.
It was pointed out that to help solve the problem, we were going to let the top bar (representing the whole) take the place of the price of something, before a person saved. Now, if a person bought something and he saved one half of the price, then that meant that a person paid only half as much. At this point the bar representing halves was used to illustrate that when a person takes half of a whole away, he has a half left. The same process was used to illustrate how much of the whole is saved when a person saves one third. But one of the children made this comment, "I would rather save a half than a third, because a half is more." This fact, of course, is easily seen by looking at the visual aid. The class from this child's comment generalized that one half is more than one third.

Seeing what each fractional part looks like. At this point one piece on each bar was pushed to one side. The following conversation illustrates the thinking of the children.

Teacher: We learned that this (the piece representing one half,) is one half. We also learned that this piece (the piece representing a third) is called one third. Now what should we call each of the other pieces?

Child: The next piece should be one fourth, because four comes after three.

Teacher: Well, then, if we continue to think like that what would this piece be?

Class: One fifth.
The children seemed to experience very little difficulty in knowing what to call each piece. It should also be pointed out that the class as a whole had little difficulty in writing these fractions in their numerical form, such as 1/3, 1/4, 1/8.

During the course of the day the writer noticed many children going to the visual aid and saying to each other what one piece was, or what two pieces might be. But some of the children would count down from the top before giving the fraction a name. For example, if a child asked for the answer to a fraction representing one sixth, the second child might count down from the top and seeing that the fraction in question was on the sixth line, he would say it was one sixth or two sixths, or whatever the number in question might be. It was, therefore, the conclusion of the writer that some of the children did not yet see how a fraction gets its name from its denominator.

The following day, when the subject of fractions was mentioned, the writer noted that the children again could call the fractions by name with very little difficulty. The writer then asked, "Why is this fraction one third?" One child simply said that it was one third because it was one third. Another child said that it was one third because it was bigger than one fourth, but not as big as one half. Finally, the remark was made that it was one third because the bar was cut into three pieces and the piece in question was just one of the three pieces. Suddenly the children
realized that the bar representing fifths had five pieces, the bar representing sixths had six pieces, et cetera. It was also discovered by the children that three thirds, four fourths, eight eighths, for example, were all equal to each other, and these in turn were equal to one whole.

At this point in the children's learning the writer made small signs and placed them next to the corresponding bar. These cards were left on the visual aid for several days, and then removed. Whenever fractions were talked about or used, they were written in their numerical form so that the children could become accustomed to seeing them written as symbols.

Finding how one fraction may be equal to two or more fractional parts. After the visual aid was introduced to the children, their understanding of fractions increased. Interest in fractions seemed to increase also. The children's concept, however, was limited to what a fraction is, and that certain fractions are, in proportion, larger than others. One day a child asked the writer if the class might play a game with fractions. According to the child the game would be played by having a boy or girl go to the chalk board and write two fractions. The child who could say which was larger could then write the next two on the chalk board. Most of the children expressed a wish to try this, so it was done. At first the children wrote only those fractions which had the number one for the numerator, such as one fourth, one third, and the like. The children also wrote fractions
with different numerators, but usually kept the same denominator. After each series of fractions was written on the board, the children also compared the two fractions on the visual aid to see if the child gave the correct answer. The children were not introduced to the terms numerator or denominator at this time, and referred to these terms as the "top number" and the "bottom number." The children were aware, however, that the top number is "how many you're talking about," and the bottom number is "how many there are altogether."

On the day following, the children again wanted to play the "game" of writing two different fractions and picking out the smaller or larger one. The "game" proceeded in the same manner except for one important difference. The children were having very little trouble telling which fraction was the larger or smaller. Some of the children, in an effort to challenge the other children, began to write fractions whose numerators and denominators were different. In comparing the fractions on the visual aid, the children discovered two new and valuable facts. First of all, the children discovered that some fractions, regardless of "the top or bottom numbers" are equal. For example, three sixths and one half are equal, but when written in numerical form no two of the numbers are the same.

One child wrote the improper fraction, four thirds. When the child tried to find the fraction four thirds on the visual aid, he was unable to do so. The visual aid does not express a fraction whose value equals more than one whole.
FIGURE 5

This figure illustrates that one half, two fourths, three sixths, four eighths, five tenths and six twelfths are all equal to each other.
FIGURE 6

Figure 6 illustrates that the fractions one third, two sixths, three ninths, and four twelfths are equal to each other.
One child said it this way. "Four thirds isn't a right fraction." Upon further analysis, the children realized that four thirds really equals one whole and one third "extra" (more).

The discovery of these two facts led directly to teaching the children how to tell if a fraction is larger or smaller than another without the use of the visual aid, and how to change improper fractions to mixed numbers. The technical names "numerator", "denominator", "proper", "improper", and "terms" were given to the children. However, the children were permitted to use their own names. The term top number and bottom number have been mentioned previously. Some children developed the phrase "top heavy" when referring to improper fractions.

It was usually a regular procedure for the children to want to take about ten minutes to play their "game". Now the game took on several new aspects in that the child at the board stated specific directions for the group to consider in answering definite problems posed. On occasions the children would write a fraction on the chalk board and ask for a fraction which was its equal. Sometimes the children would make up little problems and ask the children to give an answer. This is typical of the kind of problem used. A child would say, "My father said he would give me two fourths of a dollar or five tenths of a dollar for cutting the grass. Which one would you take?" Upon giving an answer it was usually verified with the visual aid.
How the colors helped the children. One day the writer observed a child examining the visual aid. The child stated that he knew the secret of the visual aid. When asked to explain, the child stated that one could tell "which fractions were the same by knowing the trick." The writer noticed that this particular child was usually among the first to be ready to give the answer to a question or problem asked by another child. The writer announced to the class that the child had discovered a secret about the visual aid. Several of the children wanted to know, but the child was enjoying his popularity too much to tell. By the next day however, several of the children knew "the secret". Finally, the children told the rest of the class. In effect, the children explained that if a person was using a fraction painted red on the visual aid, then a certain number of the other red fractions will be equal to it. In other words, the children discovered that the fractions painted red—which are the halves, fourths and eighths—and the fractions painted yellow,—which are the thirds, and ninths—could in some way be correlated. It took another day for the children to realize that the fractions which were painted red and yellow would work with either the fractions painted red or the fractions painted yellow. That is to say that sixths which are painted yellow and red, could be equated to both halves and thirds.

The discovery by the children that the colors on the visual aid serve a purpose was very beneficial in helping them to understand that certain fractions are common to each
other, in that they are equal in proportion to each other.

The real value of the colors on the visual aid did not become apparent until the children became interested in the four processes in fractions. The discovery that certain fractions can be converted to other fractions led to the children's learning how to change fractions to either lower, or higher terms. Many of the children, however, seemed to know that some fractions could be changed to others without having to use a process. It is the writer's opinion that the children remembered readily because they saw the comparison on the visual aid; they were interested; and many problems which were real for the children were used to make fractions meaningful for the children.

How the four processes operate. It is the writer's opinion that before any of the processes be introduced to children, they must use many concrete and semi-concrete experiences in order to develop the meaning of fractions. Along with this visual aid, many other learning materials were used to help children understand fractions. The writer felt that before any of his group would benefit from learning the four fundamental processes, they must be able to identify a given fraction; reproduce a given fraction; compare a given fraction with others and understand that a fraction is a ratio, or one or more parts of a group. The writer also feels that before the four fundamental processes are taught, the child should understand the following:

1. What proper fractions are.
2. What improper fractions are and how one converts them to mixed numbers.

3. What a mixed number is.

4. Certain fractions can be changed to lower terms.

5. Certain fractions can be changed to higher terms.

6. What the numerator means.

7. What the denominator means.

In the opinion of the writer, it is very important that the child verify any given response. In this way the child's response has meaning, or if incorrect the child can see his error. The visual aid being discussed seemed to be very valuable in this respect. For example, if a child responds that three fourths are larger than two thirds, he can see, by using the visual aid, that his answer is wrong, and since he sees fractions in proportion to other fractions, he probably will understand their true relationship. When the children understand what a fraction is, as well as understanding the points listed above, they are then ready to understand the four fundamental processes.

In introducing fractions, just as in introducing any process to children, the teacher should use concrete or objective material, and, if possible, stimulate the desire for learning by using examples which are both real and a part of the lives of children. It is not the writer's purpose to show how fractions can be introduced, but rather to show how a visual aid that is a contrived experience may help to make the four processes in fractions more meaningful to children.

The addition of fractions. There are two kinds of experiences in the addition of fractions to which children
should be introduced. The first kind has to do with the addition of fractions with like denominators. The second kind relates to adding fractions with unlike denominators.

The visual aid seems to make the addition of fractions with like denominators quite apparent. For example, all a child has to do to add three eighths and four eighths is to first slide three eighths over to one side, count out four eighths more, and then count the total number of eighths present.

When the sum totals more than one whole the visual aid can be used meaningfully. If a child is concerned with finding the answer to the problem two fourths and three fourths for example, the visual aid might well be operated in the following manner. The child should think two fourths and then slide each of the other three fourths over, counting each piece as he moves it. In this way the child should arrive at the answer, five fourths. Five fourths, although improper, should present little difficulty since the children should understand what an improper fraction is, and how to change them to mixed numbers, before they learn any of the processes.

The fraction five fourths can be shown by using the top bar, and an additional one fourth. The top bar is equal to four fourths, or to one whole. Five fourths are equal to one whole and one fourth.

The addition of fractions with unlike denominators may present a little more difficulty. Perhaps the child's
FIGURE 7

In adding fractions with unlike denominators the denominators must first be made common. In this picture, the problem represented was that of adding one sixth to one third. The picture shows that two sixths are equal to one third. Two sixths and one sixth are three sixths.
FIGURE 8

This picture is used to illustrate that one fourth and one fourth equal two fourths. Two fourths are equal to one half.
first reaction when adding a fraction like one fourth to two eighths is to add both the numerator and denominator. However, this should not be a stumbling block if the children have made certain generalizations when learning how to add like fractions. The children should have generalized, if the fractions were taught meaningfully, that fractions must have the same denominator before they can be added; the numerator in the answer is the sum of the numerators in the problem; the denominator in the answer is the same as the denominator in the problem.

It is at this point in the teaching of fractions that the colors on the visual aid serve their greatest purpose. The writer has already mentioned that his group discovered that the colors were correlated through one child becoming aware of that fact and then reporting to the other children. When the children are aware of the meaning of the colors, it should be quite simple to find a common denominator for the fractions involved. For example, in adding fractions whose denominators are fourths and eighths respectively, the child should be able to see that both of these fractions are painted a red color; therefore the denominator of the two fractions can be changed to a fraction having a red color. If the problem was adding one fourth to three eighths, one fourth can be changed to two eighths and the sum will total five eighths.

In adding fractions which have unrelated denominators, such as one fourth and one third, the solution should present
no difficulty. One fourth is painted red. One third is painted yellow. Therefore, these fractions can be converted to some fraction which is both red and yellow in color. Sixths cannot be used since fourths do not line up with sixths. The only other fraction which can be used is twelfths.

The visual aid shows that one fourth equals three twelfths, and one third equals four twelfths. Three twelfths and four twelfths are seven twelfths.

The colors are also useful in helping children understand the changing of fractions to lower terms. A child having an answer of four eighths sees that on the visual aid eighths are painted red. The other fractions which are painted red are fourths and halves. The fraction having the lowest term are the halves, therefore eighths should be changed to halves.

In some cases a fraction cannot be changed to lower terms. The fraction three eighths is an example. The visual aid under discussion shows that three eighths are not equal to any other fraction, but the fraction four eighths and one half line up evenly, and therefore are equal and one can be changed to the other.

The subtraction of fractions. Many of the suggestions which were made in discussing the addition of fractions can also be said about the process of subtraction. In fact, all of the processes necessary in addition are also necessary in understanding the process of subtracting fractions. The
generalizations which applied to adding fractions should also apply to subtracting fractions. The basic experience and understanding necessary properly to understand the addition of fractions also is necessary to understanding the subtraction of fractions.

In the writer's opinion, there are only two major differences between adding and subtracting fractions. One difference is that the children must take away instead of add to the fractions. The other difference lies in the fact that the children must learn to borrow.

As in the addition of fractions, there are also two kinds of fractions in the process of subtraction. Children should learn how to subtract fractions with like denominators as well as those with unlike denominators.

**Subtraction of fractions with like denominators.** If the children understand the addition of fractions, learning to subtract fractions with like denominators should be relatively simple. For example, in using the visual aid to subtract five eighths from seven eighths, all a child need do is count seven eighths and slide them to one side, take five eighths back and count the remaining eighths, which are two. Here again the child should use what he has learned about changing fractions to lowest terms and change his answer from two eighths to one fourth.

**Subtracting fractions with unlike denominators.** The children should also experience little difficulty in subtracting fractions with unlike denominators, providing ther
FIGURE 9

This figure illustrates the problem one fourth minus one eighth. One fourth is equal to two eighths. Two eighths less one eighth is one eighth.
FIGURE 10

Figure 10 is used here to represent the problem one half minus three eighths. One half has been converted to four eighths. Three eighths are being subtracted from the four, leaving one eighth as the remainder.
is no borrowing involved. By using the same fundamentals involved in changing one denominator to another, which was learned when adding fractions, the children need only subtract the fractions instead of adding them. The visual aid may be used to clear up any misconceptions, or to verify answers, once the children have used the visual aid and other concrete learning materials to understand the process.

**Subtracting fractions which involve borrowing.** By using the visual aid, the children can readily see that four fourths, two halves, five fifths and fractions like these, are equal to one whole. The children should also be able to generalize that one whole is equal to the sum of the parts. The visual aid can be used to help children understand borrowing in this way. If the problem one whole minus one fourth is used, the orange bar representing one whole is used to represent the one whole in the problem. A fourth may be slid under it. The children should then be shown (if they do not already know) that one whole equals four fourths. Changing one whole to four fourths and subtracting one fourth leaves a remainder of three fourths.

In solving problems which involve mixed numbers, the child would proceed as in addition, changing the denominators so that they are common. After the denominators are changed the child would then compare the fractions to see if borrowing is necessary. If borrowing is necessary before the fractions can be subtracted, the one whole is simply borrowed and changed into terms of fractions concerned and added to the fraction represented.
For example, four and two fourths minus two and three fourths, would be three and six fourths minus two and three fourths after borrowing.

The visual aid is not constructed to show wholes greater than one. However, in working with mixed numbers, the fraction part can be worked on the visual aid if the need arises.

**Multiplication of fractions.** The writer again points out that pupils may or may not see the need for knowing how to multiply fractions, or what is more important, understanding what multiplication of fractions means. It is again pointed out that if a teacher finds it impractical to teach fractions as they apply to the lives of the children, he should at least introduce the process through problems which are met in daily living.

The visual aid which is being discussed is so constructed that it will, in the writer's opinion, make two aspects in the multiplication of fractions sufficiently meaningful for children. It will first of all show what it means to multiply fractions. Along with this aspect it is stated that the visual aid helps the children understand the process of multiplying a fraction by a fraction. Secondly, the visual aid can be used to help children understand the multiplication of a fraction by a whole number.

**Fractions multiplied by fractions.** It is the writer's observation that many children have difficulty with multiplication of fractions because they do not understand what multiplication of fractions means. In the problem one half times one half many children give the response of one whole.
Now, what these children evidently do is add. However in multiplication the "times" can almost always be substituted by the term "of". Therefore, when one substitutes he has one half of one half. In using the visual aid to work this problem, the child can merely slide the bar representing the half over to one side. If the bar representing the half were cut in half (this can be done by using two fourths instead of one half) it can be seen that a half of one half is really one fourth. The one fourth is in terms of the whole. The children should generalize that in multiplication of fractions, you really take a given fraction and divide it into so many parts, with the response depending on the number of parts concerned in relation to the whole. For example, one half of one fourth simply means that the fraction one half is to be divided into four parts, and the problem is concerned with how much one of the parts will be. If one half is divided into four parts, which can be done by substituting four eighths for the one half on the visual aid, one of the four parts will be equal to one eighth in terms of the whole.

Whole numbers multiplied by fractions. The visual aid is so constructed that it should help a child understand the multiplication of a fraction times any whole number through twelve. The visual aid would be used in the following way. For example, the problem two thirds of six means that the whole number six is to be divided into three parts and the child is to find how much two of the parts would be.
The bar having six pieces on it can be used for this problem, since the whole number six is involved. The six pieces are divided into three groups, each of the same number. There are two in each group. One third of six would be two. But the problem was to find out what two thirds would be. Two thirds would be twice as many as one third, or four.

**Division of fractions.** Some teachers feel that the division of fractions is the most difficult of the four processes for the children to understand. The teachers feel that children can do the process but rarely understand it.

The writer feels that the division of fractions need present no greater difficulty than any of the other processes in fractions. It is important that the child understand fractions from the beginning, and that any and all of the processes be made meaningful through the use of concrete materials and concrete examples.

Understanding the division of fractions is insured when the child understands what he does, why he does it, and what his answer means.

**Dividing a whole number by a fraction.** This should not be too difficult for children to comprehend with the use of visual aids. The visual aid being discussed might be very useful to children in helping them understand certain aspects in the process of division of fractions. For example, in the problem two divided by one fourth, the problem concerns itself with how many fourths are there in two wholes. The visual aid can be used to show that there are four fourths
in one whole, therefore in two wholes there are eight.

Dividing a fraction by a whole number. In this situation one may need to take one half and divide it by two. The problem is one of finding out how many two's there are in one half. To a child who understands fractions, the answer given would be one to the effect that there are not any two's in one half, because one half is less than one whole. To put the problem in other words, to make it more meaningful, the problem might be stated to ask what part of two wholes is one half. By using the visual aid, the children could see that it takes two halves to make one whole, or four halves to make two wholes. Since four halves are needed for two wholes, one half would be one fourth of the total.

In the actual process, the inverting of the divisor takes the place of the thinking which the writer illustrated in the above example.

Dividing a fraction by a fraction. This aspect in the division of fractions should not be too difficult for children if they know how to divide a whole number by a fraction. For example, one half divided by one fourth, means how many fourths are there in one half. The use of the visual aid will show that there are two one fourths in each half, therefore the answer for the above problem is two.

It is the thought of the writer that a teacher should make the division of fractions as meaningful as possible. However, the writer feels that the mathematical reason for inverting the divisor is beyond the understanding of most of
the children in the elementary schools. Therefore the writer feels that after the children understand division of fractions, they should be taught how to invert and multiply, even though they do not fully comprehend the mathematical reason for doing so.

In conclusion the writer would like to point out that, in teaching children, the use of more than one teaching aid may be necessary and desirable. The writer used other media to help his group understand fractions. Filmstrips, movies, pictures, charts, are all valuable. However, it is not the purpose of the paper to report on how fractions were taught, or could be taught. Its purpose is to report on how a particular visual aid can be used to help make fractions more meaningful to children.
CHAPTER IV

SUMMARY AND RECOMMENDATIONS

The writer has tried to point out that teaching today involves more than the presentation of subject matter. If children are to learn more effectively, and if there is to be meaning in their learning, the teacher must use tools to help make learning more meaningful and present material in such a way that experiences give children rich insights into the meanings of their learnings.

There are many different kinds of teaching aids available to help the teacher make learning more meaningful. However, the writer was particularly concerned with the development of a tool or visual aid which would help make fractions more meaningful to children.

General statement regarding the construction and use of the visual aid. In developing the visual aid, the writer worked toward a predetermined list of objectives and criteria. Construction was carried on in such a manner that these objectives and criteria might be realized. As many of the senses were brought into use as possible. Color was used to help the child in understanding certain aspects of processes involving fractions. The visual aid was designed to help children see what a fraction is; how some fractions are equal
to each other; what each fraction looks like in proportion to other fractions; and how the four processes operate. The writer never intended the visual aid to be the only tool used in the teaching of fractions. In fact, the writer recommends that other audio visual aids be used also. It has also been emphasized that, in teaching the four processes, the introduction of each should be made in terms of real life situations. The writer believes that rules alone are not good in teaching children mathematical processes. Rules may be helpful when the child has certain basic understandings, and when he is able to generalize from concrete examples.

The writer's experience seems to indicate that the visual aid might be very helpful to children in forming certain basic concepts concerning fractions. The visual aid also seems to be useful in the introduction of the four processes in fractions. After a knowledge of the processes and facts involved in fractions are obtained, the visual aid might be helpful in verifying results.

**Recommended improvements.** In experimenting with the visual aid the writer feels that certain improvements might be made in the visual aid to increase its effectiveness.

First, the length might be increased. The writer recommends that the length of the visual aid be increased, or the size of the pieces representing the sum of the fractional parts be decreased. The frame of the visual aid, as constructed by the writer, is forty-one inches. The bar representing the whole is equal to twenty-four inches. The
writer feels that this space is too small, since the fractional parts may equal more than seventeen inches. This may cause some of the fractions to overlap with the effect that it is distracting. The working space should be at least one inch longer than twice the size of the piece representing the whole.

A second recommendation has to do with the color of the visual aid. The bar representing elevenths is painted blue. Blue is a primary color. Red was used for halves because red is a primary color, and halves might be considered a primary fraction. Thirds were painted yellow for the same reason. However, elevenths are not a primary fraction and should not be painted a primary color. Its color might well be any color which is not a primary color and which has not already been represented on the visual aid.

A third recommendation is more in terms of what the visual aid lacks. The visual aid, as constructed, makes no provision for showing improper fractions or mixed numbers. This may not be necessary, but it is the writer's opinion that if a child could see an improper fraction it would aid him in understanding improper fractions, and would also help the children see the actual process of borrowing in fractions.

A fourth recommendation is that, through use, new values may be discovered. As children work with the teacher, the teacher should look for new and improved ways of using the visual aid. There are probably many ways of using the visual aid which have not been discussed here. The writer
feels that the visual aid should not be used as a static device. Its use should be experimental so that all of its potentialities might be discovered.
BIBLIOGRAPHY


