The Teaching of Arithmetic III: The Story of an Experiment

L. P. Benezet
Superintendent of Schools, Manchester, New Hampshire

Originally published in the *Journal of the National Education Association* Volume 25, Number 1, January, 1936, pp. 7−8

This is the third and final instalment of an article by Superintendent L. P. Benezet, in which he describes an experiment in arithmetic in the Manchester, New Hampshire, schools. The first installments [November 1935, p. 241−4 and December 1935, p. 301−3] have aroused many favorable comments. William McAndrew calls the material "powerful good reading, a scientific article free of the common dullness of such." Helen Ives Schermerhorn, of New Jersey, writes that upon returning to teach in junior high school after many years in the adult education field, she "was appalled at the changes which had taken place, the great number of new activities which had developed, each good in itself, but nevertheless cluttering up the time of the children. The weakness in English seemed inexcusable; too little time had been given to its mastery. I hope great things from the influences of Mr. Benezet's article. A letter from C. E. Birch, superintendent of schools, Lawrence, Kansas, indicates that the Lawrence schools have been revising the arithmetic program for the past two years. Mr. Birch has recommended the discussion in faculty meetings of the Benezet articles and their possible application in the light of the local situation.

Is your school making similar use of these articles? It would be an interesting thing to call some of the leading citizens in your community together around the table and read the articles to them to see what their attitude would be.

It must be understood that I knew very well what my hardest task was ahead. I had to show my more conservative teachers what we were trying to do and convert them to the idea that it could be done. I went into room after room, day after day, testing, questioning, giving out examples.

We had visitors. Two Massachusetts superintendents, a superintendent of a large Massachusetts city with five of his principals, and two instructors in the Boston Normal School came. They saw what we were trying to do and were surprised at the ability to reason and to talk, shown by children whose minds had not been chloroformed by the dull, drab memorizing of tables and combinations. But there were murmurs throughout the city. It finally broke out in a board meeting. A motion was made that we throw out the new course of study in arithmetic and go back to the old. It was defeated by a vote of nine to four, but a committee of three was appointed to study the problem carefully. Taking with me two members of the committee and a stenographer, I visited four different schools in our own city and three in a city not thirty miles away.

The most convincing test was in connection with the problem which I tried out in not less than six different rooms. Four of these rooms were made up of children who learned their arithmetic in the old formal way, whereas the other two were groups who had been taught according to the new method. In every case it was an advanced fifth grade, within one month of promotion to the 6−B.

I give verbatim accounts of two of these recitations, the first from a traditional room and the other from one of the experimental groups. I drew on the board a little diagram and spoke as follows: "Here is a wooden pole that is stuck in the mud at the bottom of a pond. There is some water above the mud and part of the pole sticks up into the air. One−half of the pole is in the mud; 2/3 of the rest is in the water; and one foot is sticking out into the air. Now, how long is the pole?"

> First child: "You multiply 1/2 by 2/3 and then you add one foot to that."
>
> Second child: "Add one foot and 2/3 and 1/2."
>
> Third child: "Add the 2/3 and 1/2 first and then add the one foot."
>
> Fourth: "Add all of them and see how long the pole is."
>
> Next child: "One foot equals 1/3. Two thirds divided into 6 equals 3 times 2 equals 6. Six and 4 equals 10. Ten and 3 equals 13 feet."

You will note that not one child saw the essential point, that 1/2 the pole was buried in the mud and the other half of it was above the mud and that 1/3 of this half equaled one foot. Their only thought was to manipulate the numbers, hoping that somehow they would get the right answer. I next asked, "Is there anybody who knows some way to get the length?"

> Next child: "One foot equals 3/3. Two−thirds and 1/2 multiplied by 6."

My next question was, "Why do you multiply by 6?"

The child, making a stab in the dark, said, "Divide."

It may be that he detected in my voice some stress on the word "multiply." I then gave them a hint which, had they been able to reason at all, should have shown them how to solve the problem. "How much of the pole is above the mud?" said I. The answer which I had hoped for was, of course, "One−half of it is above the mud."

> The first child answered: "One foot and 2/3."
>
> I looked dubious, so the second child said, "One foot and 1/3."

I then said, "I will change my question. How much of the pole is in the mud?"

> "Two−thirds," said the first child.
>
> "One−half," said the second.
>
> "One−half," said the third.

"Then how much of the pole is above the mud," said I thinking that now the answer was plainly indicated as one−half.

> "Two−thirds," said the next child.
>
> "One foot and 2/3," said the next.

"One−half of the pole is in the mud," said I. "Now, how long is the pole?" and the answers given were "Two feet." One and one−half feet." "One−half foot." "One foot." "One foot." "One foot," and I gave it up.

I gave the same problem the same week to a fifth grade in our city which had been brought up under our new curriculum, with no formal drill in addition, multiplication, and division of big numbers but with much mental work in reasoning. I drew the diagram again and said, "Here is a pond with a rock bottom and mud and water, with a pole sticking in the mud. One−half of the pole is in the mud; 2/3 of the rest of the pole is in the water; one foot of the pole sticks up in the air above the water. How long is the pole? How would you go to work to do that problem?"

> First child: "You would have to find out how many feet there are in the mud."

"And what else?" said I.

> Another child: "How many feet in the water and add them together."

"How would you go to work and get that?" said I to another child.

> "There are 3 feet in a yard. One yard is in the mud. One yard equals 36 inches. If 2/3 of the rest is in the water and one foot in the air [one foot equals twelve inches] the part in the water is twice the part in the air so that it must be 2 feet or 24 inches. If there are 3 feet above the mud and 3 feet in the mud it means that the pole is 6 feet or 72 inches long. Seventy−two inches equals 2 yards."

It amazed me to see how this child translated all the measurements into inches. As a matter of fact, to her, the problem was so simple and was solved so easily, that she could not believe that she was doing all that was necessary in telling me that the pole was 6 feet long. She had to get it into 72 inches and 2 yards to make it hard enough to justify my asking such a problem.

The next child went on to say, "One−half of the pole is in the mud and 1/2 must be above the mud. If 2/3 is in the water, then 2/3 and one foot equals 3 feet, plus the 3 feet in the mud equals 6 feet."

The problem seemed very simple to these children who had been taught to use their heads instead of their pencils.

The committee reported to the board and the board accepted their report, saying that the superintendent was on the right track. They merely suggested that, to quiet the outcry of some of the parents, the teaching of the tables should be begun a little earlier in the course.

The development of the ability to reason is one of the big results of the new course of study in arithmetic. Not long ago, hearing that a complaint had been made by the mother of a child in a 5−B room, regarding the teaching of arithmetic, I visited the room with the principal and tried to discover just what the youngsters could and could not do. I gave them several problems to test their ability to do mental arithmetic, and was surprised at the accuracy and speed with which they answered me. I then tried them on a problem which involved a little reasoning. I drew a picture of two faucets and of a pail placed beneath them. Stating that either one of the faucets could fill the pail alone in two minutes, I asked how long it would take to fill it if the two were running at the same time. Confidently expecting that the children would tell me four minutes, I was much gratified to receive the answer, one minute, from three−fourths of the class. I next changed the problem by stating that I would replace one of the faucets by a smaller one, which could fill the pail in four minutes. I then asked about how long it would take to fill the pail, if the two faucets ran together. A few told me three minutes, but the great majority guessed between one minute and two, the popular answer being about a minute and a half. I next asked what part of the pail would be filled at the end of one minute, and the children told me, without any difficulty, that it would be three−quarters full. My next question was, "How long exactly would it take, then, to fill the pail?" The first child that I called upon gave me the correct answer, one minute and twenty seconds. The principal expressed his astonishment and asked me to try the same problem on the eighth grade. I did so. These children, brought up under the old method of formal arithmetic, did not do nearly as well as did their younger brothers and sisters.

I have recently tried, in several parts of the city, a test involving five simple problems. Here it is:

1. Two boys start out together to race from Manchester to West Concord, a distance of 20 miles. One makes 4 miles an hour and the other 5 miles an hour. How long will it be before both have reached West Concord?

2. A man can row 4 miles an hour in still water. How long will it take him to row from Hill to Concord [24 miles one way] and back, if the river flows south at the rate of 2 miles an hour?

3. The same man again starts rowing from Hill to Concord in the spring when the water is high and the current is twice as swift as it was before. How long will it now take him to make the round trip?

4. Remus can eat a whole watermelon in 10 minutes. Rastus in 12. I suggest a race between them, giving each half of a melon. How long will it be before the melon is entirely gone?

5. The distance from Boston to Portland by water is 120 miles. Three steamers leave Boston, simultaneously, for Portland. One makes the trip in 10 hours, one in 12, and one in 15. How long will it be before all 3 reach Portland?

It looks easy enough, but I advise you to try it. I will guarantee that high school seniors, preparing for College Entrance Board Examinations in Mathematics, will not average 70 percent. I had some rather ridiculous results. I tried the fourth and fifth examples on a second grade the other day and had an almost perfect score, while a ninth−grade class in arithmetic, which had been taught under the old arithmetical curriculum, made a sorry showing. Out of twenty−nine in the class only six gave me the correct answer to problem five.

We have already seen results of our new course of study. The head of the English Department in our Central High−school [enrolling 2450 pupils] tells me that in the English classes made up of pupils who entered on February 1, 1935, there is a fluency and a readiness with the mother tongue that is surprising. The old−time diffidence is gone. Children are no longer tongue−tied and unable to put a new idea into words.

I am not surprised. I had expected a report like this. You will recall the terrible English used in one of our eighth grade rooms, taken down as it was spoken, which I have quoted in the first article. I went into the same room five years afterwards. The same teacher was in charge, and some of the children in the room were younger brothers and sisters of the previous group, but the methods of teaching had radically changed. With the stenographic report to the previous recitation in my hand, I asked this latter day group the same questions which I had propounded five years before to their older brothers and sisters. I pick out typical answers, and I assure you that I am not giving you the top of a "deaconed" barrel of apples.

> "When the numerators of any two fractions remain the same, the fraction with the smaller denominator is the largest."
>
> "The principle that we have proved is that the smaller the denominator gets − no, the larger the denominator gets, the smaller the fraction."
>
> "The larger the denominator is, the smaller the fraction would be if the numerator is the same."

> "The smaller the numerator gets, if the denominator remains the same, the smaller the fraction is."
>
> "The larger the denominator gets, the smaller the fraction will be, provided that the numerator remains the same."
>
> "The larger the denominator gets, provided the numerator remains the same, the smaller the fraction becomes."

I then tried an experiment which to me was the most conclusive of all. I read from the account in my hand typical answers which had been given in that same room five years before [of course they were not told that it was the same room] and these present day eighth graders shouted with laughter at statements which had not provoked a smile five years before. I asked them why they laughed and they proceeded to pick out the flaws in the reasoning and choice of words of their predecessors. To me it was the most heartening sign yet, and a prophecy of what we may expect when this present eighth grade shall have become seniors in our high schools.

Part I | Part II
Benezet Centre