DOCUMENT RESUME

ED 183 505 SP 015 382

AUTHOR	Duckworth, Eleanor
TITLE	Learning With Breadth and Depth.
INSTITUTION	City Univ. of New York, N.Y. City Coll. Workshop Center for Open Education.
PUB DATE	Jun 79
NOTE	35p.: Lecture presented at the Workshop Center for Open Education (New York, NY, May 5, 1979).
AVAILABLE FROM	Workshop Center for Open Education, Room 6, Shepard Hall, City College, Convent Ave. & 140 St., New York, NY 10031 ($2.50)
EDRS PRICE	MF01/PC02 Plus Postage.
DESCRIPTORS	Child Development: *Cognitive Processes: *Comprehension Development: Creative Thinking: *Discovery Learning: Inquiry Training: *Intellectual Development: *Learning Theories: Open Education

ABSTRACT

This booklet contains a speech on the value of discovery learning in building a sound knowledge base. The author contends that systematic concepts (such as spatial relations) should be fully explored by experimentation and discussion in the classroom. The cognitive processes involved in solving problems are examined and examples are given of several problems and the different ways in which solutions may be reached. (JD)

LEARNING with BREADTH and DEPTH

Eleanor Duckworth

The Catherine Molony
Memorial Lecture

CITY COLLEGE SCHOOL OF EDUCATION
WORKSHOP CENTER FOR OPEN EDUCATION

JUNE 1979 $2.50

This publication is part of a series of position papers, curriculum bulletins, and occasional papers published periodically by the WORKSHOP CENTER FOR OPEN EDUCATION on subjects related to open education in the public schools.

Editor: Ruth Dropkin

THE WORKSHOP CENTER FOR OPEN EDUCATION serves City College classes, and is a free facility for all teachers, administrators, paraprofessionals, and parents who are interested and involved in open education in the New York City area. Its work is supported by funds from the National Institute of Education and City College.

Founder and Director: Lillian Weber

Requests for information and publications should be addressed to THE WORKSHOP CENTER FOR OPEN EDUCATION, Room 6, Shepard Hall, City College Convent Avenue at 140th Street, New York, NY 10031.

This publication of highlights of the 1979 Spring Institute, held at the Workshop Center for Open Education on Saturday, May 5, features the first Catherine Molony Memorial Lecture and includes the introduction to the invitee, excerpts from panels and closing remarks.

CATHERINE MOLONY (1920-1977) was a beloved member of the City College Advisory Service to Open Corridors, a workshop leader at the Workshop Center, and an educator whose ideas and research on reading influenced teachers. The Memorial Lecture is planned as an annual event at City College in her honor.

The 1979 Spring Institute was made possible by the grant to the Workshop Center from the National Institute of Education, Gary Sykes, Program Officer.

An example for us all

Miriam S. Dorn

There are many things one could say about the special place in education held by Eleanor Duckworth. One of these is that she comes from Canada. (Since I come from Canada myself, I am aware of the strength of this contributing factor.)

I have memories of hearing Eleanor Duckworth on previous occasions. I was always tremendously impressed with her simultaneous translations of Piaget's speeches, because translating Piaget, especially in the early days, involved not only understanding Piaget but also creating the English words to describe ideas for which there was then no readily available language.

I was not alone in admiring her enormous gifts as translator and interpreter. I remember an annual conference of the Piaget Society held in Philadelphia a few years back. Piaget has always claimed that he spoke no English, and, I must confess, I was always a little skeptical. After all, he spends considerable time in English-speaking countries, and he must read the research. Anyhow, he was sitting on the stage of a huge, packed auditorium, with Eleanor Duckworth beside him. The chairperson introduced Eleanor first and there was tumultuous, really tumultuous applause. Piaget automatically got up and took a bow.

The audience roared, and Eleanor gently plucked at his jacket and pointed to herself. The anecdote reveals 1) that Duckworth is universally admired and 2) that Piaget, apparently, really does not understand English.

Eleanor Duckworth's translation of Piaget has gone beyond literal interpretation; it has evolved into something that stands on its own merit. On my first reading of "The Having Of Wonderful Ideas,"* I was struck by the simple fact that she, like everyone else, had trouble applying Piagetian theory to a teaching situation. In the late 50s and during the 60s when Piaget was introduced to Americans, educators felt boxed in by his theory, especially since teaching did not appear to be an important variable. Nevertheless, Piaget became fashionable. We might say that Americans were assimilating Piagetian theory, but not accommodating to it. Here is where Eleanor's contribution is so significant. Her work broke away from the old behaviorist model, away from exercises given to children to train them to conserve--and into the world of wonderful ideas. With this break--and breakthrough--she helped create a new paradigm with new possibilities for viewing children's learning.

It is certainly a major contribution, and one that she reinforced (in the good sense of the word) with many more, of which I would mention a specific one that offers a profound insight into the nature of learning. She describes Piaget's account of his friend who grew up to be a renowned mathematician. This friend told Piaget that as a child, he counted the number

*HARVARD EDUCATIONAL REVIEW, Vol. 42, No. 2, May 1972 of pebbles he had set out in a line. He counted them from left to right and found there were ten, and then he counted from right to left, and was intrigued to find that there were still ten. He put them in other arrangements, and each time there were ten. Just a childhood story told by one friend to another. Since the story was told to Piaget, however, it developed into a theory of conservation.

But Eleanor went beyond the story and raised a question, first pointing to what we already know from Piaget's accounts of his work: if ten eggs are spread out so that they take more space than ten egg cups, the classic non-conserver will maintain that there are more eggs than egg cups, even if he counts and finds that he comes to ten in both cases.

Counting is not sufficient. Eleanor's question, then, is: If counting is not sufficient, how was it sufficient for Piaget's mathematical friend? If he was a non-conserver at the time, counting should not have made any difference. If he was a conserver, he should have known from the start that it would always come out the same.

I love this question of Eleanor's; I am enamored of the kind of mind that would ask that question. It is her answer, however, that indicates the extent to which she has contributed to our insights into learning. She concludes that Piaget's friend must have been in a transitional stage to have raised the question regarding number and the order of counting for himself, and figured out for himself how to try to answer it. This question-raising on the part of the learner is what I believe tells us something about a very basic part of the learning process--transitions and accommodation.

Eleanor herself continues to raise questions and to challenge the thinking of us all, as in her recent article, "Either We're Too Early and They Can't Learn It, Or We're Too Late And They Know It Already: The Dilemma of 'Applying Piaget'."* (I would have loved to have authored that article and the title is a masterpiece!)

I hope I have made it clear that I find Eleanor's thinking profound, her questions exciting, and her contributions extensive. But I want to end on a different note. Eleanor dedicated her monograph, *The African Primary Science Program: An Evaluation and Extended Thoughts*,** to David Hawkins, who, she says, "led me to realize that I could have some significant thoughts of my own." That Eleanor was one of us in needing support was a revelation. That she chose to share her need was one of her many wonderful ideas.

[illegible], one of the authors of FOSTERING INTELLECTUAL DEVELOPMENT, *[illegible] Department of Elementary [illegible] College School [illegible].*

*THE GENETIC EPISTEMOLOGIST, Vol. VII, Nos. 3-4, July/October 1978. Parts I, II.
**Published by University of North Dakota, Grand Forks, 1978.

Learning with breadth and depth

Eleanor Duckworth

The Workshop Center for Open Education claims a remarkable position in the world of education. There are few places where practice and reflection are honored as both are here. That balance embodies a wisdom in this Teacher Center which has, in what might otherwise be depressing times, helped keep me spiritually alive.

I was particularly pleased when Lillian invited me here for the first time; that was for me an important recognition. I recall that one of the things I had planned to do with children in a demonstration caused me some misgivings. I planned to work with pendulums--I have loved pendulums since working on them with David Hawkins in the early days of the Elementary Science Study, and they also have a respectable place in Piaget's research. At that time pendulums were known to the Workshop staff as a source of beauty and playfulness: pendulums dropping sand into beautiful patterns, or a pendulum bowling game whose point was to knock down a line or a circle of standing pegs, with a single sweep.

But I wasn't going to do this playful or artistic work. I was going to do very tight problems: How long do you have to make one pendulum if it is to do twice as many swings as another? Where do you measure the length of a pendulum? (Do you measure it to the end of the string or do you measure it down to the bottom of the bob?) What difference does it make if you pull one pendulum back three times as far as another? What role does weight play? It was these very specific kinds of questions that I wanted to have the children investigate, to watch how they went about finding their answers.

I was nervous about doing that tight kind of study here; but I should have known better. Devoted though they are to beauty and playfulness, the Workshop staff were just as enthusiastic about seeing children at grips with intellectual problems. This openness and breadth of concern not only reassured me, but often, since then, helped me to think more clearly about my own values.

You are probably familiar with what Piaget refers to as "the American question": *If ideas develop on their own so slowly, what can we do to speed them up?* Piaget was very pleased a number of years ago when Howard Gruber reported to him on work he had been doing with kittens and object permanency. You know, perhaps, about the phenomenon in human infancy: Studying his own children, Piaget concluded that they were between a year and a year and a half before they realized that an object had its own continuing existence and location even when out of their reach and out of their sight. Howard Gruber studied the same problem with kittens. He found that kittens go through all the same steps that Piaget's children did, but instead of taking eighteen months, they take six weeks. This study delights Piaget. He points out that you can scarcely say that kittens are better off for having cut a year and more off the time. After all, they don't get much further. For Piaget the question is not how *fast* you go but how *far* you go.

How could it be that going fast does not mean going far? I think a useful metaphor is of the construction of a tower--all the more appropriate given that Piaget thinks of the development of intelligence as continual construction. Building a tower with one brick on top of another is a pretty speedy business. But the tower will soon reach its limits, compared with one built on a broad base or a deep foundation--which of course takes a longer time to construct.

What is the intellectual equivalent of building in breadth and depth? I think it is a matter of making connections: *breadth* could be thought of as the widely different spheres of experience that can be related to one another; *depth* can be thought of as the many different kinds of connections that can be made among different facets of our experience.

I am not sure whether or not intellectual breadth and depth can be separated from each other, except in talking about them. In this paper I shall not try to keep them separate, but shall instead try to show how learning with breadth and depth is a different matter from learning with speed.

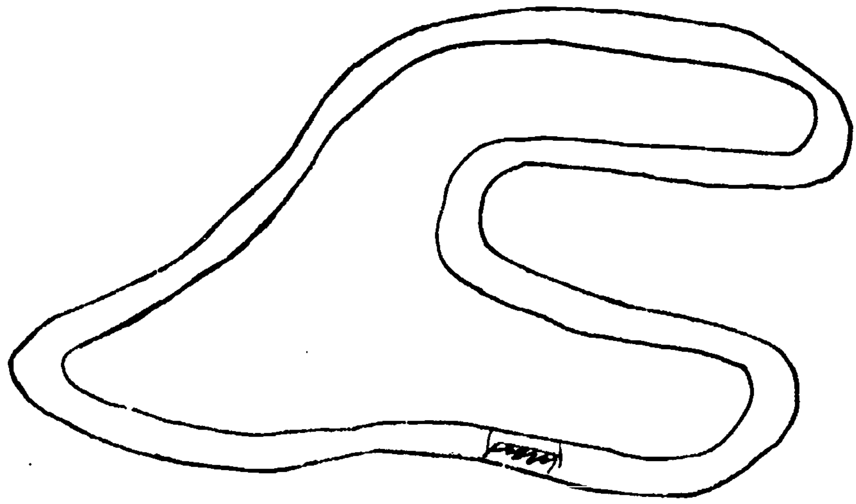
If a child spends time exploring all the possibilities of a given notion, it may mean that she holds onto it longer and moves onto the next stage less quickly; but by the time she does move on, she will have a far better foundation--the idea will serve her far better, will stand up in the face of surprises. Let me develop a hypothetical example to show what I mean, based on the notion of the conservation of area.

Let's say, you have a rectangular piece of paper and you cut it in half and rearrange the pieces. It is now a different shape from the original one yet the area is still the same.

You could think that it would be to anyone's advantage to realize early in life that a change in shape does not affect area, that no matter how a shape is transformed, its area is conserved. But I can imagine a child not managing to settle that question as soon as some other children, because she raises for herself the question of the perimeter. In fact the perimeter *does* change, and thinking about the relationship between those two is complicated work.

That child might, then, take longer than another to come to the conclusion that area is conserved, independent of shape. But her understanding will be the better for it; most children (and adults!) who arrive smartly at the notion that area is independent of shape have never thought about perimeter and are likely to get confounded if it is brought up. Having thought about perimeter on her own, she complicated the job of thinking about area; but once she straightened it out for herself, her understanding is far deeper than that of someone who has never noticed this difference between area and perimeter.

Exploring ideas can only be to the good, even if it takes time. Wrong ideas, moreover, can only be productive. Any corrected, wrong idea provides far more depth than if you never had a wrong idea to begin with. You master it much more thoroughly if you have considered alternatives, tried to work it out in areas where it didn't work, and figured out why it was that it didn't work--all of which takes time. I'd like to mention some real life examples, where making mistakes and correcting them reveal and give rise to a far better grasp of the phenomenon than if no mistakes were made at all.



One experiment involves an odd-shaped lake like the one drawn on page 9, with a road around it, and a bi-colored car on the road, one side red and one side blue. Let's say the blue side is next to the water to start with; the question is, after the car drives around a corner, or around several corners, which color will be beside the water? Six-year-olds, after one or two mistaken predictions, usually come to be quite sure that it will always be the blue. Eight-year-olds, on the other hand, can be very perplexed, and not quite get it straight, no matter how often they see the blue side come out next to the water. They keep predicting that *this* time the red side will be next to the water.

Now one might be tempted to think that the six-year-old knows more than the eight-year-old. But I think it is the greater breadth and depth of the eight-year-old's insight which leads to his perplexity. Eight-year-olds are often just at the point of organizing space into some interrelated whole: your left is opposite my right; something that you can see from your point of view may be hidden from my point of view; if a car is in front of me facing right, I see its right side, and if it turns 180 degrees I'll see its left side. With all these shifting, relative relationships, what is it about the lake that makes *that* relationship an absolute? No matter how many curves in the road, the same side is always next to the water. If a car turns 180 degrees, I thought I would see its other side; well, how is it that the *same* side is next to the water?

What is it that stays the same and

what is it that changes, after all? The six-year-old, you see, who has no idea of the systematic changes involved in some spatial relationships, has no difficulty seeing the constant in the lake problem; it is because the eight-year-old is trying to make sense of the lake in a far broader context that the right answer is not so immediate. The dawning organization of something new throws into confusion something that had been simple before. But when, a few months later, the eight-year-old or nine-year-old does start to understand that the same side must always stay next to the lake, his understanding is far deeper than the six-year-old's; it is set in the context of an understanding of spatial relationships as a whole.

Here is another example, where what appears to be less facility really indicates greater understanding. I was working with two children, who happened to be brother and sister, and they were making all possible arrangements of three colors. After each of them had found all six possibilities, I added a fourth color, and they tried again. The sister, who was younger, rapidly produced a dozen, and was still going. The older brother stopped at four and declared that that's all there were. But look at what he had done. With three colors, he had made:

1 2 3
1 3 2
2 1 3
2 3 1
3 1 2
3 2 1

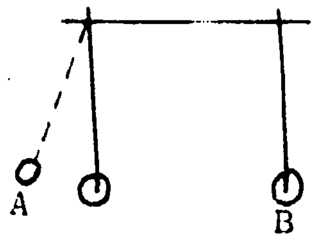
He now inserted the fourth color into part of what he had already:

4 1 2 3
1 4 3 2
2 1 4 3
2 3 1 4

It was *because* of his sense of system--his sense (which can only be called mathematical) that there was a fixed and necessary number of placements--that he stopped there: the new color was in each possible position, within a system that had all of the other colors already in each possible position. It is true that his thinking left out one step, but nonetheless his was a far deeper understanding of permutations than his sister's facile but random generation of yet more arrangements that looked different.

Getting closer to everyday concerns in the classroom, think of measurement. It can seem very straightforward: Count the number of units that apply to some quantity and there it is, measured. So many foot-long rulers in a table, plus a number of inches; so many minutes in the running of a mile, plus a number of seconds. But take this example, for which I am indebted to Judah Schwartz: You've measured the temperature of one glass of water--100 degrees; you add to it another glass of water, which is also 100 degrees. What will the temperature be now? Most of our measurement experience would lead us to say 200 degrees! And that is what a lot of children do in fact say, having easily understood *how* to add measurements together, but never having wondered *when* or *whether* to add measurements together.

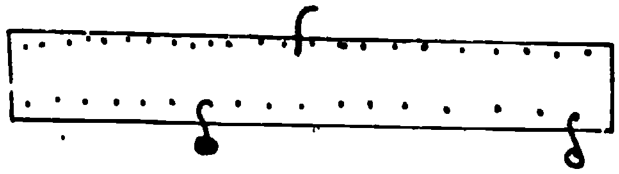
Let me, by contrast, give some examples of invention of ways of measuring, which might seem tedious and inefficient, but which are thoroughly understood by their inventors. In a class studying pendulums, children had explored coupled pendulums, set up like this: If everything is symmetrical, when you start one bob, then after a few swings the other bob starts to move; gradually bob A's movement diminishes and bob B's movement increases, until A is stopped and B is swinging widely. Then the movement passes back to A, and so on. Suppose, however, that everything is not symmetrical--the stick is tilted, or one string is longer than the other, or one bob weights more than the other.



In that case, the bob that starts swinging does pass some of its movement on to the other, but it does not come to a halt itself: the halts are asymmetric, they belong only to the bob that was at rest when the other started swinging.

That is a long introduction. The point is that in this class, a time came when the children were interested in comparing the weights of the wooden bobs and the steel bobs. Scales were available, and most of the children went to them. But Elliott, who happened to be the least scholarly child in the class, had a different idea. He set up a coupled pendulum, hung a steel bob on one string, and then added wooden bobs to the other, trying the coupled motion each time he added a bob until, at four wooden bobs, the halts were alternating symmetrically from string to string so he knew the four on one string must weigh the same as the one on the other. This astonishingly imaginative grasp of what it means to compare weights of things should be contrasted with the following tale.

In a different pendulum class, junior high school students had just been taught the equilibrium formula that applies to balances: Distance times weight on one side must equal distance times weight on the other. In this class, the only weighing mechanism available was a strip of pegboard, suspended in the center:



When they became interested in weighing the bobs, they hung a wooden bob on one end, and then a steel bob on the other side, so as to make the pegboard horizontal, announcing, "There, they weigh the same. We learned that just last week, they weigh the same." It seems clear that that formula had been hastily learned, and remained quite unexplored.

The next example comes from work we are doing this year with Jeanne Bamberger and Maggie Cawley Lampert at MIT. We are working with a group of Cambridge teachers, helping them examine their own ways of knowing in order to better understand children's ways of knowing. One kind of knowledge we were exploring was music. They were building tunes, and at one point they wanted to know whether a tune they had built had sections that were the same lengths. They didn't know how to think about that. They tried to use a watch but couldn't tell from a watch whether the first half of the tune was the same length as the second half. This led us into inventing time-measuring machines. We took a recorded tune as the standard event, and they were to construct time-measuring machines (without using watches or clocks) to tell whether some other piece of music, which we were subsequently going to play, was as long as that first piece, or longer, or shorter. They all made what we call single-purpose time-measuring machines; that is, they did not set out to find some unit that would be repeated a number of times, but instead tried to make something that measured just the length of the standard piece: water dripping out of a cup, down to a line that indicated the end of the piece; or a candle burning down just to the end of the piece.

One team made a ramp of two pieces of metal, each about four feet long. To their dismay, the ball rolled off the eight feet of ramp before the music stopped. They changed the slope; the ball still rolled off. They made a pathway on the floor at the end out of tongue depressors so that the ball could keep rolling along the floor, but now the ball stopped too soon. They changed the slope--very steep, barely any slope at all; but no matter what they did with the slope, the ball stopped too soon. They finally concluded that they would have to make the ball do something else after the roll down the ramp--otherwise they would simply have to abandon the ramp idea. So they moved the ramp up on to a long table, set it up with barely any slope at all, and arranged it so the ball could drop off at the end. Now what could they have it do when it dropped off?

Casting about for available material, they took a pan from one of the pan balances and suspended it at the end of the ramp, so the ball would fall into it. As the recorded tune started, the ball started rolling slowly down the ramp, fell into the basket at the end, thus setting it swinging, and at 32 swings of the pan the tune was ended. A single-purpose time machine it was, but a perfectly dependable one--a roll down the ramp followed by 32 swings of the pan, every time. (The tune that was to be compared with it, by the way, turned out to be a roll down the ramp followed by 37 swings of the pan; so their machine was shown to be adequate to its time-measuring task.)

These stories can be thought of as comic relief. In a sense, they are. But the comedy of the coupled pendulum and the ball on the ramp is very different from the comedy of the 200 degree water and the misinterpretation of the pegboard balance. The latter two are sad tales of too rapid assumption of understanding. The other two are the rather appealing consequences of avoiding such facile rapidity. How to measure can be taught rapidly, but when it is, the inadequacies are stunning.

It is quite different from the breadth and depth of understanding involved in messily constructing your own ways of measuring, knowing what they mean, how they are applicable or not applicable, and how they inform each new situation.

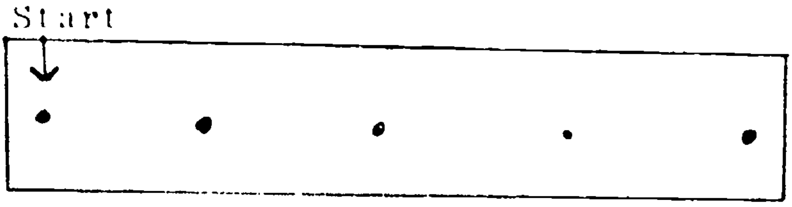
In case you may think that any adult must of course know what time measurement is about, and the only challenge was the technological one of getting some machine to work dependably, I would ask you to reflect for yourselves about how you would know without having some other readymade timer whether a candle burns with the same speed during the first quarter-inch and during the last quarter-inch. How do we know that a sweep second hand takes the same time for each one of its sweeps? How, back there in history, did anyone conclude that the same event always takes the same amount of time, and so could be used to measure the time of other events? Without a standard unit, how did they establish a standard unit? This group of teachers has given those questions a lot of thought. And here is a question that gave us pause for a long time: one of them had heard that between five and seven in the evening, demands on electricity are such that electric clocks always run slower. Is that true? If it were, how would we ever know? If it is not, why isn't it? Wouldn't any timepiece, in fact, keep going slower and slower as the battery wears out, or as the spring unwinds? For teachers, I think, one major role is to *undo* rapid assumptions of understanding, to slow down closure, in the interests of breadth and depth, which attach our knowledge to the world in which we are called upon to use it. There may, for some given situation, be one right answer, even one that is quite easily reached. But I think a teacher's job is to raise questions about even such a simple right answer--to push it to its limits, to see where it holds up and where it does not hold up. One right answer unconnected to other answers, unexplored, not pushed to its limits, necessarily means a less adequate grasp of our experience. Every time we push an idea to its limits, we find out how it relates to areas that might have seemed to have nothing to do with it. Bu virtue of that search, our understanding of the world is deepened and broadened.

I would like to develop this thought in the context of adult thinking rather than children's thinking because that is what I am currently involved with. The same group of teachers I've already referred to, who started with music and went on to measuring time, led us into the study of ramps, and the main interest of this study is that we have been pushing the limits of what seem to be ordinary, even obvious, thoughts about time, speed, and space.

The single-purpose time-measurement machines developed in the direction of a search for units of time measurement: calibrating the candle as it burned, counting the water drips, looking for natural phenomena that keep a steady rhythm. The search applied to ramps too: Could a ball rolling down a ramp give rise to units of time? This led to another question, as a preliminary: What does the speed of a ball do as it rolls down a ramp? Does it remain constant? Speed up? Slow down and then speed up? Speed up and then remain constant?

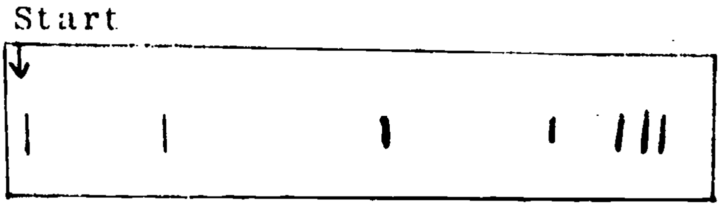
One group, watching a ball rolling down, in order to make an initial guess about the answer, noticed a spot on it. The spot came up faster and faster as the ball rolled, until by the last part of the ramp its occurrences were no longer distinguishable; it looked like a blurred continuous line.

This suggested that the ball was getting faster and faster as it rolled down the ramp, all right, but this group wanted to do a better job of it than that. It occurred to one of them that if the dot left a mark as it rolled they would be able to see better what the speed of the ball was doing. A bit of experimenting and they found a substance that they could mark the dot with and that would leave a spot each time it hit a long sheet of computer printout paper that was stretched down the ramp. Do you want to predict what the spots did? We have since discovered that about half the adults we have asked predict the dots will get closer together, a few predict they will get farther apart, and the rest predict they will remain at a constant distance. The roll of computer paper with the spots left by the ball looks like this:



And the reaction of at least one member of the group was to take a piece of string and measure the distances, saying something to the effect of, "Gee, those dots don't get closer together as noticeably as I had thought they would!"

That turned out to be just the beginning of many surprising perplexities in this consideration of speed-space-time relationships. Another group, trying to establish what the speed of a ball does as it rolls down a ramp, produced the following graph:



At a subsequent seminar, the teachers who had been absent when the two graphs were produced were given the job of interpreting them: trying to establish how each had been made, and what each of them said about the speed of the balls rolling down the ramps.

I am not going to say here how the second graph came about. My purposes are far better served if the reader puts herself to the task, because in this case the answer to the ball-ramp problem is really beside the point. What I would rather do is make vivid for you how much harder it is to think coherently about space-speed-time phenomena than it is to enunciate the formula. Let me tell you, though, a couple of the inferences our teachers made. One person thought the nature of the spots on the first graph looked as if the ball had left its own mark as it rolled; but then, she went on to say, it would have to have been rolling at the same speed all the way, so it couldn't have been rolling at the same speed all the way, so it couldn't have been rolling down a ramp.

The second graph was thought not to

have been made by the ball itself. This inference was made not on the basis of the distances between the marks, but because the marks looked as if they were drawn by a hand-held felt marker. One generally accepted thought was that marks were indicating where the ball was after equal time intervals.

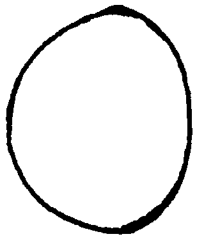
The discussion of these two graphs went on for two hours. The members of the group who had been present to generate them got caught up in considering what interpretations were possible in addition to those they knew to be the case. Does the first graph say anything about speed or not? Is anything to be learned by superimposing the first graph on the second? What picture would you get if you made both graphs at once, of one ball rolling down a ramp? What *does* the speed of the ball do in the second graph, anyway?

As I was leading this session, I never confirmed any hunch or conclusion. That was not the point. The point was to build a construction of space-time-speed ideas not rapidly, but solidly, and to know what the relationships are, after all, that are summed up in that easy high school formula. At the end of those two hours (which, remember, followed a number of other hours of experimental work and thought) no matter how I pushed the conclusions into paradoxical or counter-intuitional extremes, they resisted. No one could be seduced by what sounded like a sensible thought if it did not fit into the idea structure they had jointly created, in all of its breadth and depth.

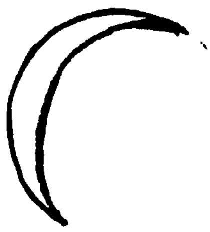
One additional topic that has been featured in our seminars this year is the moon. All of us know that the earth turns upon itself, and the moon goes around the earth, and while both these things are going on, the earth is also going around the sun. All of us also see the sky get light and dark again every day, see the sun pass overhead, often see the moon. But how many of us can make a connection between these two kinds of experience? On a particular Tuesday, for example, at five o'clock in the afternoon, the moon was slightly less than half, and it was visible quite high in the sky. Now, in a model of sun, earth, and moon, could you place them in the relative positions to indicate where they would be in order for the sky to look to us like that? Almost nobody I've run into can do that. Those two kinds of knowledge about the moon are, for the most part, quite separate. Bringing them together, moreover, is a difficult job, and, as such, this is a marvelous subject in which to study one's ways of making sense of one's experience, and especially, how a simple formal model can have almost no connection with the experience it is meant to describe.

It takes many months of watching and finding some order in the motions, before one can know, when looking at the moon, what direction it will move from there; where it will be an hour later, or twenty-four hours later; how the crescent will be tipped two hours from now; whether it has yet reached its hightest point of the night; whether, tomorrow, it will be visible in the daytime. Does the moon pass every day straight overhead? Does the moon ever pass straight overhead? Does it depend where you are on the earth? What angle would it be at if I climbed up to the top of that building? If I were sitting down? Or if I walked down the block?

Here is a question that makes direct appeal to the model: one person claimed he had seen the moon like this



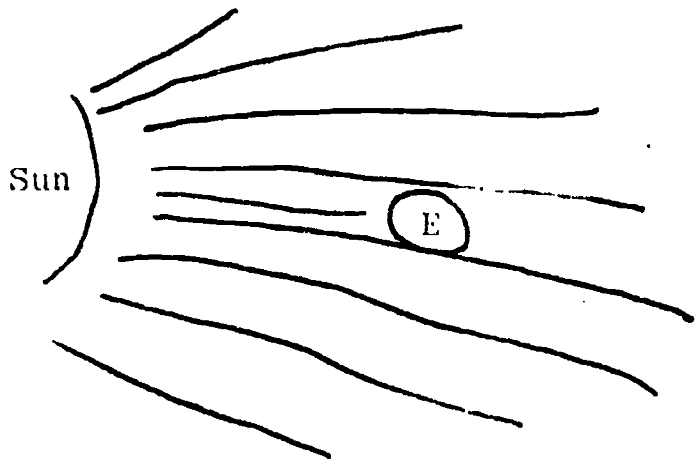
How was it possible, he asked, for the round earth to have cast a crescent-shaped shadow on the moon? He could understand seeing the moon so:



but he could not understand what he claimed to have seen. It is a good opening question for moon-watchers, and I put it to my readers, along with what seem to me three possible circumstances under which a sphere (the earth, in this case) can cast a crescent-shaped shadow or the crescent that is missing from the side of the moon is not a shadow of the earth.

For friends of the Workshop Center I can't refrain from yet one other moon insight, since it comes from Deborah Meier. She told me how perplexed she had been when she realized that people standing on the moon looked *up* to see the earth. Surely, from the moon, one should look down at the earth if, from the earth, one looks up at the moon? Figuring out that puzzle for herself was a source of considerable joy.

In our seminar, moon questions remain far from resolved, and they have taken us into sun-earth questions that are no less difficult. How, with models of earth and sun, do you represent the sun coming up over the horizon? What is the horizon, anyway, and how big is it? That is, if the sun is, for you, on the horizon, where is it for everybody else? If the sun is straight overhead at noon (and *is* it straight overhead at noon?), is it straight underfoot at midnight? If the sun's rays go out in all directions, past the earth, can we see them?



Does that mean that the part that is in darkness on earth is smaller than the part that is in light?

One of our teachers drew on the blackboard this picture of the earth in the midst of the sun's rays, and was trying to articulate her thoughts about it. Another member of the group was asking her to be more precise: Did she mean *exactly* half the earth was in darkness? Did it get suddenly black at a dividing line, or was there some gray stripe? The one who was trying to articulate her thoughts got angry, and gave up the attempt. She said later that she knew the questions were necessary at some point, but she had not been ready to be more precise; she was struggling to make sense of a morass of observations and models, some idea was just starting to take shape and, she said, "I needed time for my confusion."

That phrase has become a touchstone for me. There is, of course, no particular reason to build broad and deep knowledge about ramps, pendulums, or the moon. I choose them--both in my teaching and in discussion here--to stand for any complex knowledge. Teachers are often--and understandably--impatient for their students to develop clear and adequate ideas. But putting ideas in relation to each other is not a simple job. It is confusing; and that confusion does take time. All of us need time for our confusion if we are to build the breadth and depth that give significance to our knowledge.

[illegible], now a staff member of the Division for Study and Research in Education, Massachusetts Institute of Technology, is on leave from the University of Geneva, Switzerland, where she is an associate of Jean Piaget.

Time for learning

Lillian Weber

In the early history of our Open Corridor program we raised the issue of creating curriculum continuity and connection with a child's experience prior to school. The first changes we brought about in schools were simply arrangements to give children a chance to continue experiencing what they already had experienced. We stressed the educative force of ordinary life experience, the contribution of parents, the significance of community as a supportive for learning.

At that time we were not yet involved in any deep exploration of the inner content of the materials we urged should be present in every classroom. The teacher's own interests were secondary to our concern for the child's use of these materials. As teachers began to use their new freedom to make decisions on curriculum in which their own interests and understanding supported continuity, we may have appeared to concentrate on teachers' needs for reexperiencing their own learning. But in fact we continue to believe that a teacher's concerns are intertwined with the process of establishing the necessary conditions of support for a child's continuity and that maintaining the continuity of a child's learning process--through reengagement, reencounter, and access to materials on many levels--remains the teacher's first obligation.

Thus we still struggle for the same goals we fought for in the first stages of our work. Today teachers and children are pressured by standardized screening to determine who is educable and by rigid requirements for what is to be accomplished in a prescribed time sequence. In the current situation our commitment to heterogeneous grouping, to positive interaction that allows each person in the school to contribute to the others, and now, to mainstreaming can only be sustained by efforts in behalf of the continuity of a child's learning and of a teacher's exploration of the inner connections within curriculum. That these efforts are interdependent is made clear when a child's need to reencounter is not met because the teacher has insufficiently explored the ramifications of the material. As we have learned from Workshop Center sessions with teachers over the last seven years, a teacher's immersion in content, like a child's, does not always lead to logical or sequential questions. More often than not, it is a process in which confusions surface--or should be allowed to surface, as Eleanor Duckworth has pointed out.

A good deal of open education history is compressed between the first period of allowing a child's reengagement with materials and the present period of a teacher's engagement with content which greatly increases the possibilities for sensitive response to a child's questions. That development took time. Eleanor Duckworth's question, "Under what circumstances and conditions does the child mobilize everything she already knows for the solution of a new problem?" forces us to consider time. For just as the answer is that this kind of mobilization *does* happen in schools but only *over time*, so I would suggest that time is the issue in a real support for continuity and connections. A child's search to define, to make sense, to refine and even to take on new paths of discontinuity carrying along his continuity of memory and recognition--all this takes time. I would add my own to Duckworth's plea for time--time for reorganizing, for definition, time even for confusion.

The reality of human diversity and differences, which we took as our starting point, doesn't disappear, the fundamental issues of equity and equality don't disappear, and so our proposals and our efforts for changing schools won't disappear. Informal classrooms, I am convinced, will continue to be a legitimate and essential alternative within public education.

LILLIAN WEBER is the author of THE ENGLISH INFANT SCHOOL AND INFORMAL EDUCATION, *now available from the Workshop Center.*

CENTER PUBLICATIONS

CONTINUITY AND CONNECTIONS IN CURRICULUM, Beth Alberty with Lillian Weber, 86 pp.	$3.50
CHANGING SCHOOLS: OPEN CORRIDORS AND TEACHER CENTER Ruth Dropkin (ed.), 70 pp.	$3.50
BRONSON ALCOTT AND HENRY DAVID THOREAU, 19th-CENTURY PIONEERS IN OPEN EDUCATION, Georgia Delano, 20 pp.	$1.00
THE TEACHER AS LEARNER, Ruth Dropkin, (ed.), 58 pp.	$3.50
ROOTS OF OPEN EDUCATION IN AMERICA, Ruth Dropkin, Arthur Tobier (eds.), 201 pp.	$5.00
TEACHERS WITH CHILDREN: CURRICULUM IN OPEN CLASSROOMS Ruth Dropkin (ed.), 68 pp.	$3.50
THE OPEN EDUCATION ADVISOR Beth Alberty, Ruth Dropkin (eds.), 92 pp.	$3.50
RECOLLECTIONS OF A ONE-ROOM SCHOOLHOUSE, AN INTERVIEW WITH MARIAN BROOKS, 20 pp.	$0.75
I LIKE THE WAY I AM RIGHT NOW Jose Luis Pizarro, 40 pp.	$0.50
THE WORKSHOP CENTER SAMPLER Ruth Dropkin (ed.), 86 pp.	$2.00
TEACHING BILINGUAL CHILDREN Arthur Tobier (ed.), 54 pp.	$2.00
SCIENCE IN THE OPEN CLASSROOM Ruth Dropkin (ed.), 50 pp.	$1.50
EVALUATION RECONSIDERED Arthur Tobier (ed.), 78 pp.	$2.00

EXPLORATIONS OF VISUAL PHENOMENA, Eleanor Dimoff, 18 pp.	$0.75
READING FAILURE AND THE TESTS Deborah Meior, 38 pp.	$0.75
FIRST-YEAR EVALUATIVE STUDY OF THE WORKSHOP CENTER Educational Testing Service, 92 pp.	$1.00
THE OPEN CORRIDOR PROGRAM Martha A. Norris, Ann Hazlewood, 12 pp. Also available in Spanish as EL PROGRAMA DEL CORREDOR ABIERTO.	$0.50
NOTES FROM THE WORKSHOP CENTER FOR OPEN EDUCATION March 1972 through Summer 1979. Quarterly Journal. Back Issues.	$0.75 a copy
CUMULATIVE INDEX	$1.00

The Panels

TEACHERS:

The main thing we try to do is create an environment that continues so that a child can come back to an activity or material and keep on working out his understanding of it.

PARENTS:

It's important that we contribute our view of a child and that teachers be ready to hear what we're saying. We need more talk about our changing roles; we need those who have worked in the school to pass on their experience and history so that there will be continuity.

PRINCIPALS:

You may see, in those schools where open classrooms flourish, the connections being made between children and their out-of-school environment through parents in the school and activities and curriculum that incorporate what children are learning at home and in the community.