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*The Having of Wonderful Ideas**

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Explaining that no definitive pedagogy flows from the developmental theory of Jean Piaget, the author explores ways that classroom teachers can nevertheless make powerful use of that theory. For her, the essence of the child's intellectual development lies not in the progressive accomplishment of Piagetian tasks, but in the child's testing out the ideas that she or he finds significant. This process of testing out ideas, she argues, is critical for the child's cognitive growth. Teachers can assist this growth primarily by accepting the child's perpective as the legitimate framework for generating ideas—allowing the child to work out her or his own questions and answers. This approach—and the importance of providing varied settings and materials which suggest ideas to children—is discussed with particular reference to the author's classroom experience and her evaluation of an elementary science program.

Kevin, Stephanie and the Mathematician

The other day I was going over some classic Piaget interviews with a few children to show a friend what they were like. One involved seriation of lengths. I had cut ten cellophane drinking straws at different lengths, and was asking the children to put them in order, from smallest to biggest. The first two seven-year-olds did it with no difficulty and little interest. And then came Kevin. Before I

This article appears with the permission of Drs. Jane Roph and Milton Schwebel, editors of *Piaget in the Classroom,* to be published by Basic Books in the winter of 1972-73, copyright © Basic Books.

Harvard Educational Review Vol. 42 No. 2 May 1972

said a word about the straws, he picked them up and said to me, "I know what I'm going to do," and proceeded, on his own, to seriate them by length. He didn't mean, "I know what you're going to ask me to do." He meant, "I have a wonderful idea about what to do with these straws. You'll be surprised by my wonderful idea."

It wasn't easy for him. He needed a good deal of trial and error as he set about developing his system. But he was so pleased with himself when he accomplished his self-set task that when I decided to offer them to him to keep (ten whole drinking straws!) he glowed with joy, showed them to one or two select friends, and stored them away with other treasures in a shoe box.

The having of wonderful ideas is what I consider to be the essence of intellectual development. And I consider it the essence of pedagogy to give Kevin the occasion to have his wonderful ideas, and to let him feel good about himself for having them. To develop this point of view, and to indicate where Piaget fits in for me, I need to start with some autobiography, and I apologize for that. But it was a struggle of some years' duration for me to see how Piaget was relevant to schools at all.

I had never heard of Piaget when I first sat in one of his classes in Paris in 1957. I was fresh from a B.A. in philosophy, and it was Piaget the philosopher who won me—won me to such an extent that I went on to spend two years in Geneva as a graduate student and research assistant. Then, in 1962, I began to pay attention to schools when, as a Ph.D. drop-out, I accepted a job developing elementary science curriculum. I began the work chiefly because it was a job, but fortunately for me I had happened into an exciting circle of educators, and I got hooked.

The colleagues I admired most got along very well without any special knowledge of psychology. They trusted their own insights about when and how children were learning, and they were right. Their insights were excellent. Moreover, they were especially distrustful of Piaget. He hadn't yet appeared on the cover of the *Saturday Review* or the *New York Times Magazine,* and they had their own picture of him: a severe, humorless intellectual confronting a small child with questions that were surely incomprehensible, while the child tried to tell from the look in his eyes what the answer was supposed to be. No wonder the child couldn't think straight. (More than one of these colleagues first started to pay attention to Piaget when they saw a photo of him. He may be Swiss, they thought, but he doesn't look like Calvin: maybe he can talk to children after all.)

I myself didn't know what to think. My colleagues did not seem to be any the worse for not taking Piaget seriously. Nor, I had to admit, did I seem any the bet-

ter. Compared with psychology labs, schools were such complicated places that I couldn't find a way to be of any special help. Not only did Piaget seem to be irrelevant, I was no longer sure he was right. For a couple of years, I scarcely ever mentioned him, and simply went about the business of trying to be helpful, never, as I recall, drawing directly on any of his specific findings.

The lowest point came when one of my colleagues gleefully showed me an essay written in first grade by six-year-old Stephanie. The children had been investigating capillary tubes, looking at the difference in the height of the water as a function of the diameter of the tube. Stephanie's essay went as follows: "I know why it looks like there's more in the skinny tube. Because it's higher. But the other is fatter, so there's the same."

My colleague triumphantly took this as proof that six-year-olds can reason about the compensation of two dimensions. And I didn't know what to say. Of course, it should have been simple. Some six-year-olds *can* reason about compensations. The ages that Piaget mentions are only norms, not universals. Some children develop slower and some develop faster. But I was so unsure of myself at that point that the incident shook me badly, and my explanation only sounded like a lame excuse.

I do have something else to say about that incident, but I'll get to it a little later. For now, I simply want to describe the struggle.

Even if I did believe that Piaget was right, how could he be helpful? If the main thing we take from Piaget is that before certain ages children are unable to understand certain things—conservation, transitivity, spatial coordinates—then what can we do about it? Do we try to teach the children these things? Probably not, because on the one hand Piaget leads us to believe that we probably won't be very successful at it. And on the other hand, if there is one thing we have learned from Piaget, it is that children can be left to their own devices in coming to understand these notions. We don't have to try to furnish them. It took a few months before I straightened that out for myself and concluded that this was not a very good way to make use of Piaget.

Another alternative was to keep in mind the limits on children's abilities to classify, conserve, seriate, and so forth when deciding what to teach them at certain ages. But I found that this was an inadequate criterion for deciding what to teach. There was so much else to keep in mind. The most obvious reason, of course, was that in any class of children there is great diversity of levels. Tailoring to an average level of development is sure to miss a large proportion of the children. In addition, a Piagetian psychologist has no monopoly here. When try-

ing to approximate the abilities of a group of children of some given age, able teachers like my colleagues could make as good approximations as I.

I found it appealing that the people with whom I was working judged the merits of any suggestion by how well it worked in classrooms. That is, instead of deciding on *a priori* grounds what children *ought* to know, or what they *ought* to be able to do at a certain age, they found activities, lessons, points of departure which would engage children in ordinary classrooms, with ordinary teachers. In their view, it was easy to devise all-embracing schemes of how science, as it was in this instance, could be organized for children, but making things work pedagogically in classrooms was the difficult part. They started with the difficult part. A theory of intellectual development might have been the basis of a theoretical framework for a curriculum. But in making things work in a classroom, it was but a small part compared with finding ways to interest children, to take into account different children's interests and abilities, to help teachers with no special training in the subject, and so forth. So the burden of this curriculum effort was classroom trials. The criterion was whether or not they worked, and their working depended only in part on their being at the right intellectual level for the children. They might be perfectly all right, from the point of view of intellectual demands, and yet fall short in other ways. Most often, it was a complex combination.

As I was struggling to find some framework within which my knowledge of Piaget would be useful, I found, more or less incidentally, that I was starting to be useful myself. As an observer for some of the pilot teaching of this program, and later as a pilot teacher myself, I found that I did have some good insights into the intellectual difficulties that children encountered. I had a certain skill in being able to watch and listen to children and figure out how they were really seeing a problem. And this led to a certain ability to raise questions that made sense to them and to think of a new orientation for activities which might correspond better to their way of seeing things. I don't want to suggest that I was unique in this. Many of the excellent teachers with whom I was in contact had similar insights. So did many of the mathematicians and scientists among my colleagues, who, from their points of view, could tell when children were seeing things differently from the ways they did. But the question of whether I was unique is not really pertinent. The point is that my experience with Piaget, working closely with one child at a time and trying to figure out what was really in his mind, was a wonderful background for being sensitive to children in classrooms. I feel that a certain amount of this kind of background would be similarly useful for every teacher.

In my own development, it was this sensitivity to children in classrooms which continued to be central. As a framework for thinking about learning, my understanding of Piaget has been invaluable. This understanding, however, has also been deepened by working with teachers and children on questions of how they can best spend their time together. I may be able to shed some light on that mutual relationship by referring again to six-year-old Stephanie's essay on compensation.

Few of us, looking at water rise in capillary tubes of different diameters, would have bothered to wonder whether the quantities were the same. Nobody had asked Stephanie to make that comparison and in fact it is impossible to tell just by looking. But, on her own, she felt it was a significant thing to comment upon. I take that as an indication that for her it was a wonderful idea. Not long before, she believed that there was more in the tube where the water was higher. She had recently won her own intellectual struggle on that issue, and she wanted to point out her finding to the world for the benefit of those who might be taken in by preliminary appearances.

This incident, once I had figured it out, helped me think about a point that bothered me in one of Piaget's anecdotes. You may recall Piaget's account of a mathematician friend who inspired his studies of the conservation of number. This man told Piaget about an incident from his childhood, where he counted a number of pebbles he had set out in a line. Having counted them from left to right and found there were ten, he decided to see how many there would be if he counted them from right to left. Intrigued to find that there were still ten, he put them in a different arrangement and counted them again. And he kept rearranging and counting them until he decided that, no matter what the arrangement, he was always going to find that there were ten—number is independent of the order of counting.

The problem for me was this: in Piaget's accounts of his subjects, if ten eggs are spread out so they take more space than ten eggcups, a classic non-conserver will maintain that there are more eggs than eggcups, even if he counts and finds that he comes to ten in both cases. Counting is not sufficient to convince him that there are enough egg-cups for all the eggs. How is it, then, that for the mathematician, counting was sufficient? If he was a non-conserver at the time, counting shouldn't have made any difference. If he was a conserver, then he should have known from the start that it would always come out the same.

I think it must be that the whole enterprise was his own wonderful idea. He raised the question for himself, and figured out, for himself, how to try to answer it. In essence, I am saying that he was in a transitional moment, and Stephanie

and Kevin were, too. He was at a point where a certain experience fit into certain thoughts, and he took them a step forward.

I think a powerful pedagogical point can be made from this. These three instances dramatize it, because they deal with children moving ahead with Piaget notions, which are usually difficult to advance with any one experience. The point has two aspects: first, the right question at the right time can move children to peaks in their thinking which result in significant steps forward and real intellectual excitement; and second, although it is almost impossible for an adult to know exactly the right time for a given question for a given child—especially for a teacher who is concerned with thirty or more children—children can raise the right question for themselves when the setting is right. And once the right question is raised, they are moved to tax themselves to the fullest to find an answer. The answers did not come easily in any of these three cases, but the children were prepared to work them through. Having confidence in one's ideas doesn't mean, "I know my ideas are right"; it means, "I am willing to try out my ideas."

As I put together experiences like these and continued to think about them, I started developing some ideas about what education could be, and about the relationships between education and intellectual development.

Hank

It is a truism that all children in their first year or two make incredible intellectual advances. Piaget has documented these advances from his own point of view, but every parent and every psychologist knows this to be the case. One recurring question is why, for such vast numbers of children, does intellectual development slow down so? What happens to children's curiosity and resourcefulness later in their childhood? Why do so few continue to have their own wonderful ideas? I think part of the answer is that intellectual breakthroughs come to be less and less valued. Either they are dismissed as being trivial—as Kevin's or Stephanie's or the mathematician's might have been by some adults. Or else they are discouraged as being unacceptable—like seeing how it feels to wear shoes on the wrong feet (witness Sesame Street), or asking questions that are socially embarrassing, or destroying something to see what it's like inside. The effect is to discourage children from exploring their own ideas, and to make them feel that they have no important ideas of their own—only silly or evil ones.

But I think there is at least one other part of the answer, too. Wonderful ideas

cannot spring out of nothing. They build on a foundation of other ideas. The following incident may help to clarify what I mean.

Hank was an energetic and not very scholarly fifth-grader. His class has been learning about electric circuits with flashlight batteries, bulbs, and various wires. After the children had developed considerable familiarity with these materials and what they do, the teacher made a number of mystery boxes. Two wires came from each box, but inside, unseen, each box had a different way of making contact between the wires. In one box the wires were attached to a battery; in another box they were attached to a bulb; in another box they were attached to a certain length of resistance wire; in another box they were not attached at all. By trying to complete the circuit on the outside of a box, the children were able to figure out what made the connection inside the box. Like many other children, Hank attached a battery and a bulb to the wire outside the box. Since the bulb lit, he knew at least that the wires inside the box were connected in some way. But since it was somewhat dimmer than usual, he also knew that the wires inside were not connected directly to each other and that they were not connected by another piece of ordinary copper wire. Along with many other children, he knew that the degree of dimness of this bulb meant that the wires inside were connected either by another bulb of the same kind or by a certain kind of resistance wire.

This was as far as the teacher expected them to be able to go. But in order to push the children to think a little further, she asked them if there was any way to tell whether it was bulb or a piece of wire inside the box. She herself thought there was no way to tell. But after some thought, Hank had an idea. He undid the battery and bulb that he had already attached on the outside of the box. In their place, and using additional copper wire, he attached six batteries in a series. He had already experimented enough to know that six batteries would burn out a bulb, if it was a bulb inside the box. And he knew that once a bulb is burnt out, it no longer keeps the circuit complete. So he then attached the original battery and bulb again. This time he found that the bulb on the outside of the box did not light. So he reasoned, with justice, that there had been a bulb inside the box, and now it was burnt out. If there had been a wire inside, it would not have burned through, and the bulb on the outside would still light.

Note that to carry out that idea, Hank had to take the risk of destroying a light bulb. In fact, he did destroy one. In accepting this idea, the teacher had to accept not only the fact that Hank had a good idea which even she did not have, but also accept that it was worthwhile to destroy a small bit of property for the sake of following through an idea. These features almost turn the incident into a

parable. Without these kinds of acceptance, Hank would not have been able to pursue his idea. Think of how many times this acceptance is not forthcoming in the life of any child.

But the other important point to be made here is that in order to have that wonderful idea, Hank had to know a lot about batteries, bulbs, and wires. A good deal of previous work and familiarity with those materials were a necessary aspect of this occasion.

David Hawkins has said of curriculum development, "You don't want to cover a subject; you want to uncover it." That, it seems to me, is what schools should be about. They can help to uncover parts of the world which children would not otherwise know how to tackle. Wonderful ideas build on other wonderful ideas. They are not had without content. In Piaget's terms, you have to reach out to the world with your own intellectual tools and grasp it, assimilate it, yourself. All kinds of things are hidden from us—even though they surround us—unless we know how to reach out for them. Schools and teachers can provide materials and questions in ways that suggest things to be done with them; and children, in the doing, cannot help being inventive.

There are two aspects to providing occasions for wonderful ideas, then. One is being prepared to accept children's ideas. The other is providing a setting which suggests wonderful ideas to children—different ideas to different children —as they get caught up in intellectual problems that are real to them.

What Schools Can Do

Recently I had the chance to evaluate an elementary school science program. It happened to be in Africa, but for the purposes of this discussion there is nothing special about the African setting. The program might have been anywhere. This program was by no means a deliberate attempt to apply Piaget, as that is usually understood. But it was, to my mind, an application of Piaget in the best sense. The assumptions that lay behind the work would correspond very well with Piaget's views of the nature of learning and intellectual development. In fact, they correspond with the ideas I have just been developing. The program set out to reveal the world to children. They wanted the children to be familiar with the material world—with biological phenomena, physical phenomena, technological phenomena—flashlights, mosquito larvae, clouds, clay. When I speak of familiarity, I mean feeling at home with these things—knowing what to expect of them and what can be done with them; knowing how they react to vari-

ous circumstances; what you like about them and what you don't like about them; how they can be changed, avoided, preserved, destroyed, enhanced.

Certainly the material world is too diverse and too complex for anyone to become familiar with all of it in the course of an elementary school career. So the best one can do is to make such knowledge, such familiarity, seem interesting and accessible to the child. That is, one can familiarize children with a few phenomena in such a way as to catch their interest, to let them raise and answer their own questions, to let them realize that what they can do is significant—so that they have the interest, the ability, and the self-confidence to go on by themselves.

Such a program is a curriculum if you will, but a curriculum with a difference. The difference can best be characterized by saying that the unexpected is valued. Instead of expecting teachers and children to do only what was specified in the booklets, without missing anything, the aim of the program is for children and teachers to have so many unanticipated ideas of their own about what to do with the materials that they never even use the booklets. The point of developing materials at all is to get teachers and children started producing their own ideas and following through on their own, and if possible getting beyond needing anybody else's suggestions. This goal is never likely to be completely realized, of course. But as an ideal it represents the orientation of the program. It is a rather radical view of curriculum development.

It is just as necessary for teachers as for children to feel confidence in their own ideas. It is important for them as people, and also important if they are really going to feel free to acknowledge the children's ideas. If teachers feel that their class must do things just as the book says, and that their excellence as a teacher depends upon that, they cannot possibly accept children's divergence and children's creations. A teacher's guide must give enough indications, enough suggestions, so the teacher has ideas to start with and to pursue in some depth. But it must also enable the teacher to feel free to move in directions of her own when other ideas arise.

For instance, the teachers' guides for this program include many examples of things children are likely to do. The risk is that teachers may see these as things that the children in their classes must do—whether or not the children do them becomes a measure of successful or unsuccessful teaching. Sometimes the writers of the teachers' guides intentionally omit mention of some of the most exciting activities because they almost always happen even when they are not arranged. If the teacher expected them, often they would be forced, and they would no longer happen with the excitement of wonderful ideas. Often the writers include

extreme examples, so extreme that teachers wouldn't really expect them to happen in their own classes. These examples are meant to convey the message that "even if the children do this it's OK! Look, in one class they even did that!" This often seems more fruitful than putting in more common examples, whose message is more likely to be "this is what ought to happen in your class."

The teachers' guides dealt with materials which were readily available in or out of schools, and suggested activities that could be done with these materials so that children became interested in them and started asking their own questions. For instance, there are common substances all around us which provide the essential basis of chemistry knowledge. They interact together in all sorts of interesting ways, accessible to all of us if only we know how to reach out for them. This is a good instance of a part of the world which is waiting to be uncovered. How can it be uncovered for children in a way which gives them an interest in continuing to find out about it, a way which gives them the occasion to take their own initiatives, and to feel at home in this part of the world?

The teachers' guide suggested starting with salt, sugar, cassava starch, alum, lemon juice, and water. Some of these when mixed together cause bubbles. Which combinations cause bubbles? How long does the bubbling last? How can it be kept going longer? What other substances might cause bubbles? If a combination is bubbling, what else could be added that would stop the bubbling? Other things change colour when they are mixed together, and the same sorts of questions can be asked of them.

Written teachers' guides, however, cannot bear the burden alone, where this kind of teaching is totally new. To get this program started, a great deal of teacher education was necessary as well. I will not try to go into any detail, but there seemed to be three major aspects to such teacher education. One is that teachers themselves learn the same way that children in their classes will be learning. Almost any one of the units developed in this program is as effective with adults as with children, so the teachers learn through some of the units themselves, and they can see what it feels like to learn in this way. Another major aspect seems to be working with one or two children at a time, so that teachers can observe children closely enough to realize what is involved for the children. The third major aspect is seeing films or live demonstrations of a class of children, so teachers can start to feel that it really is possible to conduct their class in this way.

There is a fourth aspect of a slightly different nature. Except for the rare teacher who will take this leap entirely on her own, on the basis of a single course and some written teachers' guides, it is important to provide most teachers with the

support of at least some others nearby trying to do the same thing, with whom they can share notes. It is even better when there is somebody experienced whom they can consult when problems arise.

An Evaluation Study

What children do in one of these classrooms may be lively and interesting, but it would be nice to be able to know what difference it makes to them in the long run. I thought it would be important to compare in some way the children who had been in this program with children who hadn't, and to try to show in some standard situation that they now act differently.

I had two thoughts about ways in which these children might be different. The first was based on the following fact: many teachers had told us that when they taught this way, children improved in generating their own ideas of what to do, at raising questions, and at answering their own questions. That is, they improved at having their own ideas and being confident about their own ideas. My first thought, then, was to see whether this was really the case.

My second idea was more ambitious. If these children had really become more intellectually alert, so that their minds were alive and working not only in school but outside school, they might, over a long enough period of time, make significant headway in their operational thinking as compared to other children.

In sum, these two aspects would put to the test my notion that the development of intelligence is a matter of having wonderful ideas and feeling confident enough to try them out; and my idea that schools can have an effect on the continuing development of wonderful ideas. The study has been written up elsewhere, but let me give a summary of it here.[1]

The evaluation study had two phases. The procedures for the first phase were inspired in part by a physics examination that was given to students at M.I.T. by Philip Morrison, in which each student was given the same set of materials but was given no specific problem. Instead, the problem was to ***find*** a problem, and then to work on it. For Professor Morrison the essential task was finding the question, just as it was for Kevin, Stephanie, and the mathematician. In this examination clear differences emerged in the extent of knowledge and inventiveness revealed in the problems the students set themselves, and the work they did was only as good as their problems.

[1] For a full report, see Eleanor Duckworth, "A Comparison Study for Evaluating Primary School Science in Africa," African Primary Science Program of Education Development Center, Newton, Mass., October, 1971.

In our evaluation study we had to modify this procedure somewhat to make it appropriate for children as young as six years of age. We wanted to see what children with a year or more of experience in our program would do with materials when they were left on their own, without any teacher at all. We wanted to see whether children who had been in this program in fact had more ideas about what to do with materials than other children.

The materials we chose were not, of course, those which children in the program had spent time studying. We chose materials of two sorts. On the one hand, there were imported materials which none of the children had ever seen before —plastic color filters, geometric pattern blocks, folding mirrors, commercial building sets, for example. On the other hand, we chose some materials that were familiar to all the children whether or not they had been in the program—cigarette foil, match boxes, rubber rings from inner tubes, scraps of wire and wood and metal, empty spools, and so forth.

From each class we chose a dozen children at random, and told them—in their own vernacular—to go into the room and do whatever they wanted with the materials they found there. We told them they could move around the room, talk to each other, and work with their friends. By way of brief—and inadequate—summary of this phase, let me say that we found that the children who had been in the program did indeed have more ideas about how to work with these materials. Typically, the children in these classes would take a first look at what was offered, try a few things, and then settle down to work at something, with involvement and concentration. Children sometimes worked alone and sometimes collaborated. They carried materials from table to table, using them in ways we had not anticipated. As time went on, there was no sign that they were running out of ideas. On the contrary, their work became more and more interesting, so that it was always a disappointment to have to stop them after forty minutes.

By contrast, the other children had a much smaller range of ideas about what to do with the materials. They tended to copy a few leaders and tended to leave one piece of work fairly soon and switch to something else. There were few instances of elaborate work where a child spent much time and effort to overcome difficulties. In some of these classes, after thirty or thirty-five minutes, all the children had run out of ideas and had nothing left to do.

We looked at two things: diversity of ideas in a class, and depth to which the ideas were pursued. The experimental classes were clearly ahead in each of these two dimensions.

Our procedure was actually a substitute for what we would have liked to do. Ideally, we wanted to know whether the experience of these children in the pro-

gram had the effect of making them more alert and aware of the possibilities in ordinary things around them, questioning and exploring, during the time they spent outside school hours. This would have been an intriguing question to try to answer directly, but we did not have the time to tackle it. The procedure which we did develop, as just described, may have been too close to the school setting to give rise to any valid conclusions about the children's activity outside school. But if you can accept with me, tentatively, the thought that our results might indicate a greater intellectual alertness in general—a tendency to have wonderful ideas—then the next phase takes on a considerable interest.

I am hypothesizing that this alertness is the motor of development in operational thinking. No doubt there is a continuum. No child would be without any at all. But some would be far more alert than others. I am also hypothesizing that a child's alertness is not fixed. By opening up to children the many fascinating aspects of the world of ordinary things, and by enabling them to feel that their ideas are worth having and following through, I think that their tendency to have wonderful ideas could be affected in significant ways. This program seemed to be doing both those things, and by the time I went to evaluate, some classes of children had been in it for up to three years. It seemed to me that we might—just might—find that the two or three years of increased alertness which this program had fostered made some difference in their intellectual development.

In the second phase, then, we examined the same children individually, on Piaget-type problems, administered by a trained assistant who spoke the language of the children. A statistical analysis revealed that on five of the six problems we studied, the children in the experimental classes did significantly better than the children in the comparison classes.

I find this to be a pretty stunning result on the whole. It is the only program I know of which even suggests that something happening in schools might make a difference to operational development.

But I want to insist on one particular view of the result. I do not, in any way, want to suggest that the important thing for education to be about is acceleration of Piaget stages. I want to make a theoretical point. My thesis at the outset of this paper was that the development of intelligence is a matter of having wonderful ideas. In other words, it is a creative affair. When children are afforded the occasions to be intellectually creative—by being offered matter to be concerned about intellectually and by having their ideas accepted—then not only do they learn about the world, but their general intellectual ability is stimulated as a happy side effect.

Another way of putting this is that I think the distinction made between

"divergent" and "convergent" thinking is over-simple. Even to think through a problem to its most appropriate end-point (convergent) one must create various hypotheses to check out (divergent). When Hank came up with a closed end-point to the problem, it was the result of a brilliantly imaginative—divergent—thought. We have to conceive of the possibilities before we can check them out.

Conclusion

I am suggesting, in this paper, that children do not have a built-in pace of intellectual development. Or I would be willing to temper that to say that the built-in aspect of the pace is minimal. The having of wonderful ideas, which I am suggesting is the essence of intellectual development, would depend instead to an overwhelming extent on the occasions for having them. I have already dwelt at some length on how important it is to allow children to accept their own ideas, and work them through. I would like now to consider the intellectual basis for new ideas.

I react strongly against the thought that all we need to provide for children is a set of intellectual processes, a dry, contentless set of tools which they can then go about applying. I believe that the tools cannot help but develop, once children have something real to think about. And if they don't have anything real to think about, they won't apply tools anyway. That is, there really is no such thing as a contentless intellectual tool. If you have some knowledge at your disposal then you can try to make sense of new experiences and new information related to it. You fit it into what you have. Let me make it clear that by content I do not mean verbal summaries of somebody else's knowledge. I am not urging a return to textbooks and lectures. I mean a person's own repertoire of thoughts and actions and connections and predictions and feelings. Some of them may have their source in something the child has read or heard. But he has done the work of putting them together for himself, and they give rise to new ways for him to put them together for himself.

The greater the child's repertory of actions and thoughts—in Piaget's terms, *schemes*—the more matter he has for trying to put things together in his head. The essence of the African program I described is to increase children's repertories of actions they might carry out on ordinary things, which in turn gives rise to the need to make more intellectual connections.

Let us think of a child who has had the world of common substances opened to him, as I described earlier. He now has a vastly increased repertory of actions and connections to make. He has seen that when you boil away sea water, a salt

residue remains. Would some residue remain if he boiled away beer? If he dissolved this residue in water again, would he have beer again—flat beer? He has seen that he can get a colored liquid from flower petals if he crushes them. Could he get that liquid to dissolve in water and make colored water? Could he make colored coconut oil this way? All these questions and the actions they prompt are based on familiarity he has gained with the possibilities contained in the world of common substances.

I think intelligence cannot develop without content. Making new connections depends on knowing enough about something in the first place to be able to think of other things to do, of other questions to ask, which demand the more complex connections in order to make sense of it all. The more ideas a person already has at his disposal, the more new ideas occur, and the more he can coordinate to build up still more complicated schemes.

Piaget has speculated that some people may reach the level of formal operations in some specific area which they know well—auto mechanics, for example —without reaching the formal level in other areas. That fits into what I am trying to say. In an area you know well, you can think of many possibilities, and working them through often makes demands of a formal nature. If there is no area in which you are familiar enough with the phenomena to have to make sense of complex relationships, then you are not likely to have to develop formal operations. Knowing enough about things is one prerequisite for wonderful ideas.

And one closing remark. The wonderful ideas I am referring to need not necessarily look wonderful to the outside world. I think there is no difference in kind between wonderful ideas which many other people have already had, and wonderful ideas which nobody has happened upon before. That is, the nature of creative intellectual acts remains the same, whether it is an infant who for the first time makes the connection between seeing things and reaching for them, or Kevin who had the idea of putting straws in order of their length, or a cook who conceives of a new combination of herbs, or an astronomer who develops a new theory of the creation of the universe. In each case, it is a matter of making new connections between things already mastered.

The more we can help children to have their own wonderful ideas, and feel good about themselves for having them, the more likely it is that they will some day happen upon ideas that nobody also has happened upon before.

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