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WE begin with the hypothesis that any subject can be taught effectively in some intellectually honest form to any child at any stage of development. It is a bold hypothesis and an essential one in thinking about the nature of a curriculum. No evidence exists to contradict it; considerable evidence is being amassed that supports it.

To make clear what is implied, let us examine three general ideas. The first has to do with the process of intellectual development in children, the second with the act of learning, and the third with the notion of the "spiral curriculum" introduced earlier.

Intellectual development. Research on the intellectual development of the child highlights the fact that at each stage of development the child has a characteristic way of viewing the world and explaining it to himself. The task of teaching a subject to a child at any particular age is one of representing the structure of that subject in terms of the child's way of viewing things. The task can be thought of as one of translation. The general hypothesis that has just been stated is premised on the considered judgment that any idea can be represented honestly and usefully in the thought forms of children of school age, and that these first representations can later be made more powerful and precise the more easily by virtue of this early learning. To illustrate and support this view,

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we present here a somewhat detailed picture of the course of intellectual development, along with some suggestions about teaching at different stages of it.

The work of Piaget and others suggests that, roughly speaking, one may distinguish three stages in the intellectual development of the child. The first stage need not concern us in detail, for it is characteristic principally of the pre-school child. In this stage, which ends (at least for Swiss school children) around the fifth or sixth year, the child's mental work consists principally in establishing relationships between experience and action; his concern is with manipulating the world through action. This stage corresponds roughly to the period from the first development of language to the point at which the child learns to manipulate symbols. In this so-called preoperational stage, the principal symbolic achievement is that the child learns how to represent the external world through symbols established by simple generalization; things are represented as equivalent in terms of sharing some common property. But the child's symbolic world does not make a clear separation between internal motives and feelings on the one hand and external reality on the other. The sun moves because God pushes it, and the stars, like himself, have to go to bed. The child is little able to separate his own goals from the means for achieving them, and when he has to make corrections in his activity after unsuccessful attempts at manipulating reality, he does so by what are called intuitive regulations rather than by symbolic operations, the former being of a crude trial-and-error nature rather than the result of taking thought.

What is principally lacking at this stage of develop-

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ment is what the Geneva school has called the concept of reversibility. When the shape of an object is changed, as when one changes the shape of a ball of plasticene, the preoperational child cannot grasp the idea that it can be brought back readily to its original state. Because of this fundamental lack the child cannot understand certain fundamental ideas that lie at the basis of mathematics and physics—the mathematical idea that one conserves quantity even when one partitions a set of things into subgroups, or the physical idea that one conserves mass and weight even though one transforms the shape of an object. It goes without saying that teachers are severely limited in transmitting concepts to a child at this stage, even in a highly intuitive manner.

The second stage of development—and now the child is in school—is called the stage of concrete operations. This stage is operational in contrast to the preceding stage, which is merely active. An operation is a type of action: it can be carried out rather directly by the manipulation of objects, or internally, as when one manipulates the symbols that represent things and relations in one's mind. Roughly, an operation is a means of getting data about the real world into the mind and there transforming them so that they can be organized and used selectively in the solution of problems. Assume a child is presented with a pinball machine which bounces a ball off a wall at an angle. Let us find out what he appreciates about the relation between the angle of incidence and the angle of reflection. The young child sees no problem: for him, the ball travels in an arc, touching the wall on the way. The somewhat older child, say age ten, sees the two angles as roughly related

—as one changes so does the other. The still older child begins to grasp that there is a fixed relation between the two, and usually says it is a right angle. Finally, the thirteen- or fourteen-year-old, often by pointing the ejector directly at the wall and seeing the ball come back at the ejector, gets the idea that the two angles are equal. Each way of looking at the phenomenon represents the result of an operation in this sense, and the child's thinking is constrained by his way of pulling his observations together.

An operation differs from simple action or goal-directed behavior in that it is internalized and reversible. "Internalized" means that the child does not have to go about his problem-solving any longer by overt trial and error, but can actually carry out trial and error in his head. Reversibility is present because operations are seen as characterized where appropriate by what is called "complete compensation"; that is to say, an operation can be compensated for by an inverse operation. If marbles, for example, are divided into subgroups, the child can grasp intuitively that the original collection of marbles can be restored by being added back together again. The child tips a balance scale too far with a weight and then searches systematically for a lighter weight or for something with which to get the scale rebalanced. He may carry reversibility too far by assuming that a piece of paper, once burned, can also be restored.

With the advent of concrete operations, the child develops an internalized structure with which to operate. In the example of the balance scale, the structure is a serial order of weights that the child has in his mind.

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Such internal structures are of the essence. They are the internalized symbolic systems by which the child represents the world, as in the example of the pinball machine and the angles of incidence and reflection. It is into the language of these internal structures that one must translate ideas if the child is to grasp them.

But concrete operations, though they are guided by the logic of classes and the logic of relations, are means for structuring only immediately present reality. The child is able to give structure to the things he encounters, but he is not yet readily able to deal with possibilities not directly before him or not already experienced. This is not to say that children operating concretely are not able to anticipate things that are not present. Rather, it is that they do not command the operations for conjuring up systematically the full range of alternative possibilities that could exist at any given time. They cannot go systematically beyond the information given them to a description of what else might occur. Somewhere between ten and fourteen years of age the child passes into a third stage, which is called the stage of "formal operations" by the Geneva school.

Now the child's intellectual activity seems to be based upon an ability to operate on hypothetical propositions rather than being constrained to what he has experienced or what is before him. The child can now think of possible variables and even deduce potential relationships that can later be verified by experiment or observation. Intellectual operations now appear to be predicated upon the same kinds of logical operations that are the stock in trade of the logician, the scientist, or the abstract thinker. It is at this point that the child

is able to give formal or axiomatic expression to the concrete ideas that before guided his problem-solving but could not be described or formally understood.

Earlier, while the child is in the stage of concrete operations, he is capable of grasping intuitively and concretely a great many of the basic ideas of mathematics, the sciences, the humanities, and the social sciences. But he can do so only in terms of concrete operations. It can be demonstrated that fifth-grade children can play mathematical games with rules modeled on highly advanced mathematics; indeed, they can arrive at these rules inductively and learn how to work with them. They will flounder, however, if one attempts to force upon them a formal mathematical description of what they have been doing, though they are perfectly capable of guiding their behavior by these rules. At the Woods Hole Conference we were privileged to see a demonstration of teaching in which fifth-grade children very rapidly grasped central ideas from the theory of functions, although had the teacher attempted to explain to them what the theory of functions was, he would have drawn a blank. Later, at the appropriate stage of development and given a certain amount of practice in concrete operations, the time would be ripe for introducing them to the necessary formalism.

What is most important for teaching basic concepts is that the child be helped to pass progressively from concrete thinking to the utilization of more conceptually adequate modes of thought. But it is futile to attempt this by presenting formal explanations based on a logic that is distant from the child's manner of thinking and sterile in its implications for him. Much teaching in

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mathematics is of this sort. The child learns not to understand mathematical order but rather to apply certain devices or recipes without understanding their significance and connectedness. They are not translated into his way of thinking. Given this inappropriate start, he is easily led to believe that the important thing is for him to be "accurate"—though accuracy has less to do with mathematics than with computation. Perhaps the most striking example of this type of thing is to be found in the manner in which the high school student meets Euclidian geometry for the first time, as a set of axioms and theorems, without having had some experience with simple geometric configurations and the intuitive means whereby one deals with them. If the child were earlier given the concepts and strategies in the form of intuitive geometry at a level that he could easily follow, he might be far better able to grasp deeply the meaning of the theorems and axioms to which he is exposed later.

But the intellectual development of the child is no clockwork sequence of events; it also responds to influences from the environment, notably the school environment. Thus instruction in scientific ideas, even at the elementary level, need not follow slavishly the natural course of cognitive development in the child. It can also lead intellectual development by providing challenging but usable opportunities for the child to forge ahead in his development. Experience has shown that it is worth the effort to provide the growing child with problems that tempt him into next stages of development. As David Page, one of the most experienced teachers of elementary mathematics, has commented: "In teaching from kindergarten to graduate school, I have been

amazed at the intellectual similarity of human beings at all ages, although children are perhaps more spontaneous, creative, and energetic than adults. As far as I am concerned young children learn almost anything faster than adults do if it can be given to them in terms they understand. Giving the material to them in terms they understand, interestingly enough, turns out to involve knowing the mathematics oneself, and the better one knows it, the better it can be taught. It is appropriate that we warn ourselves to be careful of assigning an absolute level of difficulty to any particular topic. When I tell mathematicians that fourth-grade students can go a long way into 'set theory' a few of them reply: 'Of course.' Most of them are startled. The latter ones are completely wrong in assuming that 'set theory' is intrinsically difficult. Of course it may be that nothing is intrinsically difficult. We just have to wait until the proper point of view and corresponding language for presenting it are revealed. Given particular subject matter or a particular concept, it is easy to ask trivial questions or to lead the child to ask trivial questions. It is also easy to ask impossibly difficult questions. The trick is to find the medium questions that can be answered and that take you somewhere. This is the big job of teachers and textbooks." One leads the child by the well-wrought "medium questions" to move more rapidly through the stages of intellectual development, to a deeper understanding of mathematical, physical, and historical principles. We must know far more about the ways in which this can be done.

Professor Inhelder of Geneva was asked to suggest ways in which the child could be moved along faster

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through the various stages of intellectual development in mathematics and physics. What follows is part of a memorandum she prepared for the Conference.

“The most elementary forms of reasoning—whether logical, arithmetical, geometrical, or physical—rest on the principle of the invariance of quantities: that the whole remains, whatever may be the arrangement of its parts, the change of its form, or its displacement in space or time. The principle of invariance is no *a priori* datum of the mind, nor is it the product of purely empirical observation. The child discovers invariance in a manner comparable to scientific discoveries generally. Grasping the idea of invariance is beset with difficulties for the child, often unsuspected by teachers. To the young child, numerical wholes, spatial dimensions, and physical quantities do not seem to remain constant but to dilate or contract as they are operated upon. The total number of beads in a box remains the same whether subdivided into two, three, or ten piles. It is this that is so hard for the child to understand. The young child perceives changes as operating in one direction without being able to grasp the idea that certain fundamental features of things remain constant over change, or that if they change the change is reversible.

“A few examples among many used in studying the child’s concept of invariance will illustrate the kinds of materials one could use to help him to learn the concept more easily. The child transfers beads of a known quantity or liquids of a known volume from one receptacle to another, one receptacle being tall and narrow, the other flat and wide. The young child believes there is more in the tall receptacle than the flat one. Now the

child can be confronted concretely with the nature of one-to-one correspondence between two versions of the same quantity. For there is an easy technique of checking: the beads can be counted or the liquid measured in some standard way. The same operations work for the conservation of spatial quantity if one uses a set of sticks for length or a set of tiles for surface, or by having the child transform the shape of volumes made up of the same number of blocks. In physics dissolving sugar or transforming the shapes of balls of plasticene while conserving volume provides comparable instruction. If teaching fails to bring the child properly from his perceptual, primitive notions to a proper intuition of the idea of invariance, the result is that he will count without having acquired the idea of the invariance of numerical quantities. Or he will use geometrical measures while remaining ignorant of the operation of transitivity—that if A includes B, and B includes C, then A also includes C. In physics he will apply calculations to imperfectly understood physical notions such as weight, volume, speed, and time. A teaching method that takes into account the natural thought processes will allow the child to discover such principles of invariance by giving him an opportunity to progress beyond his own primitive mode of thinking through confrontation by concrete data—as when he notes that liquid that looks greater in volume in a tall, thin receptacle is in fact the same as that quantity in a flat, low vessel. Concrete activity that becomes increasingly formal is what leads the child to the kind of mental mobility that approaches the naturally reversible operations of mathematics and logic. The child gradually comes to sense that any change may be men-

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tally cancelled out by the reverse operation—addition by subtraction—or that a change may be counterbalanced by a reciprocal change.

“A child often focuses on only one aspect of a phenomenon at a time, and this interferes with his understanding. We can set up little teaching experiments in such a way that he is forced to pay attention to other aspects. Thus, children up to about age seven estimate the speed of two automobiles by assuming that the one that gets there first is the faster, or that if one passes the other it is faster. To overcome such errors, one can, by using toy automobiles, show that two objects starting at different distances from a finish line cannot be judged by which one arrives first, or show that one car can pass another by circling it and still not finish first. These are simple exercises, but they speed the child toward attending to several features of a situation at once.

“In view of all this it seems highly arbitrary and very likely incorrect to delay the teaching, for example, of Euclidian or metric geometry until the end of the primary grades, particularly when projective geometry has not been given earlier. So too with the teaching of physics, which has much in it that can be profitably taught at an inductive or intuitive level much earlier. Basic notions in these fields are perfectly accessible to children of seven to ten years of age, *provided that they are divorced from their mathematical expression and studied through materials that the child can handle himself.*

“Another matter relates particularly to the ordering of a mathematics curriculum. Often the sequence of psychological development follows more closely the axiomatic order of a subject matter than it does the his-

torical order of development of concepts within the field. One observes, for instance, that certain topological notions, such as connection, separation, being interior to, and so forth, precede the formation of Euclidian and projective notions in geometry, though the former ideas are newer in their formalism in the history of mathematics than the latter. If any special justification were needed for teaching the structure of a subject in its proper logical or axiomatic order rather than its order of historical development, this should provide it. This is not to say that there may not be situations where the historical order is important from the point of view of its cultural or pedagogical relevance.

“As for teaching geometrical notions of perspective and projection, again there is much that can be done by the use of experiments and demonstrations that rest on the child’s operational capacity to analyze concrete experience. We have watched children work with an apparatus in which rings of different diameter are placed at different positions between a candle and a screen with a fixed distance between them so that the rings cast shadows of varying sizes on the screen. The child learns how the cast shadow changes size as a function of the distance of the ring from the light source. By bringing to the child such concrete experience of light in revealing situations, we teach him maneuvers that in the end permit him to understand the general ideas underlying projective geometry.

“These examples lead us to think that it is possible to draw up methods of teaching the basic ideas in science and mathematics to children considerably younger than the traditional age. It is at this earlier age that systematic

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instruction can lay a groundwork in the fundamentals that can be used later and with great profit at the secondary level.

“The teaching of probabilistic reasoning, so very common and important a feature of modern science, is hardly developed in our educational system before college. The omission is probably due to the fact that school syllabi in nearly all countries follow scientific progress with a near-disastrous time lag. But it may also be due to the widespread belief that the understanding of random phenomena depends on the learner’s grasp of the meaning of the rarity or commonness of events. And admittedly, such ideas are hard to get across to the young. Our research indicates that the understanding of random phenomena requires, rather, the use of certain concrete logical operations well within the grasp of the young child—provided these operations are free of awkward mathematical expression. Principal among these logical operations are disjunction (‘either A *or* B is true’) and combination. Games in which lots are drawn, games of roulette, and games involving a gaussian distribution of outcomes are all ideal for giving the child a basic grasp of the logical operation needed for thinking about probability. In such games, children first discover an entirely qualitative notion of chance defined as an uncertain event, contrasted with deductive certainty. The notion of probability as a fraction of certainty is discovered only later. Each of these discoveries can be made before the child ever learns the techniques of the calculus of probabilities or the formal expressions that normally go with probability theory. Interest in problems of a probabilistic nature could easily be awakened and de-

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veloped before the introduction of any statistical processes or computation. Statistical manipulation and computation are only tools to be used *after* intuitive understanding has been established. If the array of computational paraphernalia is introduced first, then more likely than not it will inhibit or kill the development of probabilistic reasoning.

“One wonders in the light of all this whether it might not be interesting to devote the first two years of school to a series of exercises in manipulating, classifying, and ordering objects in ways that highlight basic operations of logical addition, multiplication, inclusion, serial ordering, and the like. For surely these logical operations are the basis of more specific operations and concepts of all mathematics and science. It may indeed be the case that such an early science and mathematics ‘pre-curriculum’ might go a long way toward building up in the child the kind of intuitive and more inductive understanding that could be given embodiment later in formal courses in mathematics and science. The effect of such an approach would be, we think, to put more continuity into science and mathematics and also to give the child a much better and firmer comprehension of the concepts which, unless he has this early foundation, he will moulder later without being able to use them in any effective way.”

A comparable approach can surely be taken to the teaching of social studies and literature. There has been little research done on the kinds of concepts that a child brings to these subjects, although there is a wealth of observation and anecdote. Can one teach the structure of literary forms by presenting the child with the first

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part of a story and then having him complete it in the form of a comedy, a tragedy, or a farce—without ever using such words? When, for example, does the idea of “historical trend” develop, and what are its precursors in the child? How does one make a child aware of literary style? Perhaps the child can discover the idea of style through the presentation of the same content written in drastically different styles, in the manner of Beerbohm’s *Christmas Garland*. Again, there is no reason to believe that any subject cannot be taught to any child at virtually any age in some form.

Here one is immediately faced with the question of the economy of teaching. One can argue that it might be better to wait until the child is thirteen or fourteen before beginning geometry so that the projective and intuitive first steps can immediately be followed up by a full formal presentation of the subject. Is it worth while to train the young inductively so that they may discover the basic order of knowledge before they can appreciate its formalism? In Professor Inhelder’s memorandum, it was suggested that the first two grades might be given over to training the child in the basic logical operations that underlie instruction in mathematics and science. There is evidence to indicate that such rigorous and relevant early training has the effect of making later learning easier. Indeed the experiments on “learning set” seem to indicate just that—that one not only learns specifics but in so doing learns how to learn. So important is training per se that monkeys who have been given extensive training in problem solving suffer considerably less loss and recover more quickly after induced brain damage than animals who had not been previously thus

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educated. But the danger of such early training may be that it has the effect of training out original but deviant ideas. There is no evidence available on the subject, and much is needed.

The act of learning. Learning a subject seems to involve three almost simultaneous processes. First there is *acquisition* of new information—often information that runs counter to or is a replacement for what the person has previously known implicitly or explicitly. At the very least it is a refinement of previous knowledge. Thus one teaches a student Newton's laws of motion, which violate the testimony of the senses. Or in teaching a student about wave mechanics, one violates the student's belief in mechanical impact as the sole source of real energy transfer. Or one bucks the language and its built-in way of thinking in terms of "wasting energy" by introducing the student to the conservation theorem in physics which asserts that no energy is lost. More often the situation is less drastic, as when one teaches the details of the circulatory system to a student who already knows vaguely or intuitively that blood circulates.

A second aspect of learning may be called *transformation*—the process of manipulating knowledge to make it fit new tasks. We learn to "unmask" or analyze information, to order it in a way that permits extrapolation or interpolation or conversion into another form. Transformation comprises the ways we deal with information in order to go beyond it.

A third aspect of learning is *evaluation*: checking whether the way we have manipulated information is adequate to the task. Is the generalization fitting, have we extrapolated appropriately, are we operating proper-

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ly? Often a teacher is crucial in helping with evaluation, but much of it takes place by judgments of plausibility without our actually being able to check rigorously whether we are correct in our efforts.

In the learning of any subject matter, there is usually a series of episodes, each episode involving the three processes. Photosynthesis might reasonably comprise material for a learning episode in biology, fitted into a more comprehensive learning experience such as learning about the conversion of energy generally. At its best a learning episode reflects what has gone before it and permits one to generalize beyond it.

A learning episode can be brief or long, contain many ideas or a few. How sustained an episode a learner is willing to undergo depends upon what the person expects to get from his efforts, in the sense of such external things as grades but also in the sense of a gain in understanding.

We usually tailor material to the capacities and needs of students by manipulating learning episodes in several ways: by shortening or lengthening the episode, by piling on extrinsic rewards in the form of praise and gold stars, or by dramatizing the shock of recognition of what the material means when fully understood. The unit in a curriculum is meant to be a recognition of the importance of learning episodes, though many units drag on with no climax in understanding. There is a surprising lack of research on how one most wisely devises adequate learning episodes for children at different ages and in different subject matters. There are many questions that need answers based on careful research, and to some of these we turn now.

There is, to begin with, the question of the balance between extrinsic rewards and intrinsic ones. There has been much written on the role of reward and punishment in learning, but very little indeed on the role of interest and curiosity and the lure of discovery. If it is our intention as teachers to inure the child to longer and longer episodes of learning, it may well be that intrinsic rewards in the form of quickened awareness and understanding will have to be emphasized far more in the detailed design of curricula. One of the least discussed ways of carrying a student through a hard unit of material is to challenge him with a chance to exercise his full powers, so that he may discover the pleasure of full and effective functioning. Good teachers know the power of this lure. Students should know what it feels like to be completely absorbed in a problem. They seldom experience this feeling in school. Given enough absorption in class, some students may be able to carry over the feeling to work done on their own.

There is a range of problems that have to do with how much emphasis should be placed on acquisition, transformation, and evaluation in a learning episode—getting facts, manipulating them, and checking one's ideas. Is it the case, for example, that it is best to give the young child a minimum set of facts first and then encourage him to draw the fullest set of implications possible from this knowledge? In short, should an episode for a young child contain little new information but emphasize what can be done to go beyond that bit on one's own? One teacher of social studies has had great success with fourth-graders through this approach: he begins, for example, with the fact that civilizations

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have most often begun in fertile river valleys—the only “fact.” The students are encouraged in class discussion to figure out why this is the case and why it would be less likely for civilizations to start in mountainous country. The effect of this approach, essentially the technique of discovery, is that the child generates information on his own, which he can then check or evaluate against the sources, getting more new information in the process. This obviously is one kind of learning episode, and doubtless it has limited applicability. What other kinds are there, and are some more appropriate to certain topics and ages than others? It is not the case that “to learn is to learn is to learn,” yet in the research literature there appears to be little recognition of differences in learning episodes.

With respect to the optimum length of a learning episode, there are a few commonsense things one can say about it, and these are perhaps interesting enough to suggest fruitful research possibilities. It seems fairly obvious, for example, that the longer and more packed the episode, the greater the pay-off must be in terms of increased power and understanding if the person is to be encouraged to move to a next episode with zest. Where grades are used as a substitute for the reward of understanding, it may well be that learning will cease as soon as grades are no longer given—at graduation.

It also seems reasonable that the more one has a sense of the structure of a subject, the more densely packed and longer a learning episode one can get through without fatigue. Indeed, the amount of new information in any learning episode is really the amount that we cannot quite fit into place at once. And there is a severe limit,

as we have already noted, on how much of such unassimilated information we can keep in mind. The estimate is that adults can handle about seven independent items of information at a time. No norms are available for children—a deplorable lack.

There are many details one can discuss concerning the shaping of learning episodes for children, but the problems that have been mentioned will suffice to give their flavor. Inasmuch as the topic is central to an understanding of how one arranges a curriculum, it seems obvious that here is an area of research that is of the first importance.

The "spiral curriculum." If one respects the ways of thought of the growing child, if one is courteous enough to translate material into his logical forms and challenging enough to tempt him to advance, then it is possible to introduce him at an early age to the ideas and styles that in later life make an educated man. We might ask, as a criterion for any subject taught in primary school, whether, when fully developed, it is worth an adult's knowing, and whether having known it as a child makes a person a better adult. If the answer to both questions is negative or ambiguous, then the material is cluttering the curriculum.

If the hypothesis with which this section was introduced is true—that any subject can be taught to any child in some honest form—then it should follow that a curriculum ought to be built around the great issues, principles, and values that a society deems worthy of the continual concern of its members. Consider two examples—the teaching of literature and of science. If it is granted, for example, that it is desirable to give

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children an awareness of the meaning of human tragedy and a sense of compassion for it, is it not possible at the earliest appropriate age to teach the literature of tragedy in a manner that illuminates but does not threaten? There are many possible ways to begin: through a re-telling of the great myths, through the use of children's classics, through presentation of and commentary on selected films that have proved themselves. Precisely what kinds of materials should be used at what age with what effect is a subject for research—research of several kinds. We may ask first about the child's conception of the tragic, and here one might proceed in much the same way that Piaget and his colleagues have proceeded in studying the child's conception of physical causality, of morality, of number, and the rest. It is only when we are equipped with such knowledge that we will be in a position to know how the child will translate whatever we present to him into his own subjective terms. Nor need we wait for all the research findings to be in before proceeding, for a skillful teacher can also experiment by attempting to teach what seems to be intuitively right for children of different ages, correcting as he goes. In time, one goes beyond to more complex versions of the same kind of literature or simply revisits some of the same books used earlier. What matters is that later teaching build upon earlier reactions to literature, that it seek to create an ever more explicit and mature understanding of the literature of tragedy. Any of the great literary forms can be handled in the same way, or any of the great themes—be it the form of comedy or the theme of identity, personal loyalty, or what not.

So too in science. If the understanding of number,

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measure, and probability is judged crucial in the pursuit of science, then instruction in these subjects should begin as intellectually honestly and as early as possible in a manner consistent with the child's forms of thought. Let the topics be developed and redeveloped in later grades. Thus, if most children are to take a tenth-grade unit in biology, need they approach the subject cold? Is it not possible, with a minimum of formal laboratory work if necessary, to introduce them to some of the major biological ideas earlier, in a spirit perhaps less exact and more intuitive?

Many curricula are originally planned with a guiding idea much like the one set forth here. But as curricula are actually executed, as they grow and change, they often lose their original form and suffer a relapse into a certain shapelessness. It is not amiss to urge that actual curricula be reexamined with an eye to the issues of continuity and development referred to in the preceding pages. One cannot predict the exact forms that revision might take; indeed, it is plain that there is now available too little research to provide adequate answers. One can only propose that appropriate research be undertaken with the greatest vigor and as soon as possible.