

## THE ROLE OF TUTORING IN PROBLEM SOLVING\*

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THIS PAPER is concerned with the nature of the tutorial process; the means whereby an adult or "expert" helps somebody who is less adult or less expert. Though its aim is general, it is expressed in terms of a particular task: a tutor seeks to teach children aged 3, 4 and 5 yr to build a particular three-dimensional structure that requires a degree of skill that is initially beyond them. It is the usual type of tutoring situation in which one member "knows the answer" and the other does not, rather like a "practical" in which only the instructor "knows how". The changing interaction of tutor and children provide our data.

A great deal of early problem solving by the developing child is of this order. Although from the earliest months of life he is a "natural" problem solver in his own right (e.g. Bruner, 1973) it is often the case that his efforts are assisted and fostered by others who are more skilful than he is (Kaye, 1970). Whether he is learning the procedures that constitute the skills of attending, communicating, manipulating objects, locomoting, or, indeed, a more effective problem solving procedure itself, there are usually others in attendance who help him on his way. Tutorial interactions are, in short, a crucial feature of infancy and childhood. Our species, moreover, appears to be the only one in which any "intentional" tutoring goes on (Bruner, 1972; Hinde, 1971). For although it is true that many of the higher primate species learn by observation of their elders (Hamburg, 1968; van Lawick-Goodall, 1968), there is no evidence that those elders do anything to *instruct* their charges in the performance of the skill in question. What distinguishes man as a species is not only his capacity for learning, but for teaching as well. It is the main aim of this paper to examine some of the major implications of this interactive, instructional relationship between the developing child and his elders for the study of skill acquisition and problem solving.

The acquisition of skill in the human child can be fruitfully conceived as a hierarchical program in which component skills are combined into "higher skills" by appropriate orchestration to meet new, more complex task requirements (Bruner, 1973). The process is analogous to problem solving in which mastery of "lower order" or constituent problems in a *sine qua non* for success with a larger problem, each level influencing the other—as with reading where the deciphering of words makes possible the deciphering of sentences, and sentences then aid in the deciphering of particular words (F. Smith, 1971). Given persistent intention in the young learner, given a "lexicon" of constituent skills, the crucial task is often one of com-

\*This research was conducted at the Center for Cognitive Studies at Harvard University under Grant MH-12623 of the U.S. National Institutes of Health.

Accepted manuscript received 1 September 1974

bining (usually in an appropriate serial order) the set of component acts necessary to achieve a particular end. The child, faced with new challenges, must match means to ends, and it is this matching (and the correction of mismatching) that is at the heart of problem solving (e.g. Saugstad and Raaheim, 1960; Newell *et al.*, 1960; Miller *et al.*, 1960).

Discussions of problem solving or skill acquisition are usually premised on the assumption that the learner is alone and unassisted. If the social context is taken into account, it is usually treated as an instance of modelling and imitation. But the intervention of a tutor may involve much more than this. More often than not, it involves a kind of "scaffolding" process that enables a child or novice to solve a problem, carry out a task or achieve a goal which would be beyond his unassisted efforts. This scaffolding consists essentially of the adult "controlling" those elements of the task that are initially beyond the learner's capacity, thus permitting him to concentrate upon and complete only those elements that are within his range of competence. The task thus proceeds to a successful conclusion. We assume, however, that the process can potentially achieve much more for the learner than an assisted completion of the task. It may result, eventually, in development of task competence by the learner at a pace that would far outstrip his unassisted efforts.

But, we would contend the learner cannot benefit from such assistance unless one paramount condition is fulfilled. In the terminology of linguistics, *comprehension of the solution must precede production*. That is to say, the learner must be able to recognize a solution to a particular class of problems before he is himself able to produce the steps leading to it without assistance. There is ample evidence from developmental psycholinguistics that for language acquisition such is almost universally the case (McNeill, 1970). Olson (1966, 1970) has similarly indicated that a child is capable of recognizing a diagonal design before he is able to construct one on a checker board, since the constituent acts of placement require more degrees of freedom (i.e. taking into account both horizontal and vertical axes) than he can handle simultaneously. Clinchy (1974), using the classic game of Twenty Questions, has likewise shown that her young subjects were able to discriminate between good strategy and bad, good questions and less good ones, if they were asked to choose between them, even though unaided they could not produce good strategies or even good questions.

It is quite obvious why comprehension *must* precede production and why in most instances it *does*. It must because without it there can be no effective feedback. One must recognize the relation between means and ends in order to benefit from "knowledge of results". There may be a marginal exception to this rule in the specialized area of learning without awareness, but it is probably a narrowly defined exception, since even bio-feedback procedures with human subjects are dependent upon the subject being able to realize when and by what means he has achieved an objective. Nevertheless, we should not overlook the role of serendipity, "the faculty of making happy and unexpected discoveries by accident". Plainly—and this will be very plain when we treat the observations of the children and their tutor—children do in fact gain a sense of possible outcomes as well as of means for achieving outcomes by a process of what on the surface looks like rather "blind" (though hardly random) trying-out behaviour. Such preliminary "blind" action may in fact be a necessary condition for the children to discover not only the nature of the

final objective, but also some of the means for achieving it. Yet, such preliminary behaviour in search of the structure of the problem often requires the support of the tutor, and may indeed be directly attributable to the tutor's role as an activator—one of the features of scaffolding to which we return in the discussion of our results.

Our concern is to examine a "natural" tutorial in the hope of gaining knowledge about natural as well as automated teaching tasks. Our observations are not to be regarded as a test of an hypothesis about the tutoring process. Rather, they are attempts at systematic descriptions of how children respond to different forms of aid. We are, as it were, involved in problem-finding rather than in problem-solving (Mackworth, 1965).

### THE TASK

Thirty children, seen in individual sessions lasting from 20 min to 1 hr, formed the sample used in the study. They were equally divided into 3-, 4-, and 5-yr-olds, each age-group in turn being equally divided between girls and boys. All 30 children were accompanied by their parents who lived within a five mile radius of Cambridge, Mass. and had replied to advertisements for subject volunteers. They were predominantly middle-class or lower middle-class.

The task set the children was designed with several objectives in mind. First and foremost, it had to be both entertaining and challenging to the child while also proving sufficiently complex to ensure that his behaviour over time could develop and change. It had to be "feature rich" in the sense of possessing a variety of relevant components. We tried to make its underlying structure repetitive so that experience at one point in task mastery could potentially be applied to later activity, and the child could benefit from after-the-fact knowledge or hindsight. But the task had not to be so difficult as to lie completely beyond the capability of any of the children. And finally, we did not want to make too great demands upon the child's manipulatory skills and sheer physical strength.

Note at the outset, then, that we have already constrained our results by the choice of a particular task; one that is "fun", one that is multifaceted and therefore "interesting", one that is within easy reach of a child's skills, and one that is continuous in its yield of knowledge. We shall revert to these matters in interpreting our results.

With these constraints in mind, the first author designed the toy illustrated in Fig. 1. The material is wood. The toy consists of 21 blocks that combine to form a pyramid standing about 9 in. high with a 9 in. square base. There are six levels in the pyramid. The top block is a solid square with a circular depression in its bottom. Each remaining layer is composed of 4 equal sized blocks made up of two locking pairs. Each pair fits together by a hole and peg arrangement. When one pair is fitted in the correct orientation, two other half pegs are brought together; the other pair brings together two half-holes. These form the means for connecting the two pairs to form the four piece layer. The blocks were designed so that all pegs would fit into all holes. In addition to pegs and holes, each four-block layer has a shallow round depression in its base and a matched elevation on top. These can only be

formed by putting the appropriate pairs together in the correct orientation, since each block possesses one-quarter of each of these larger connectives.

#### THE TUTORING PROCEDURE

The tutor's "program", which we now describe, was agreed upon in advance. By following a set of simple prescriptions the tutor endeavoured to gear her behaviour to the needs of the individual child while keeping reasonable comparability of procedure from child to child and age group to age group. Above all, her aim with every child was to allow him to do as much as possible for himself. She would always try to instruct verbally, for example, before intervening more directly, only doing the latter when the child failed to follow a verbal instruction. The child's success or failure at any point in time thus determined the tutor's next level of instruction.

When the child first came to the experimental room, he or she was seated at a small table, with the 21 blocks of various shapes and sizes spread out in a jumble. He was invited to play with the blocks. The child could have no idea what the blocks might look like when put together. He was left to his own devices for about 5 min so that he might become familiar with the blocks and the situation. The blocks were simply there, to play with if he wished.

The tutor would then usually take up two of the smallest blocks and show the child how these could be joined together to form a connected pair. If the child made up a correct pair on his own in free play, the tutor would use it as an example. She would then ask the child to "make some more like that one".

The tutor would then recognize and respond systematically to three types of response from her charge. Either the child ignored her and continued with his play; or he took up the blocks which she had just assembled and manipulated them; or he tried to make something with other blocks in a way more or less similar to the tutor's own method, by putting pegs into holes, for example. If the child had ignored her, the tutor would again present suitable and constrained material already assembled, perhaps simply joining and positioning two blocks to form a correct pair. If the child had tried to assemble pieces for himself but had overlooked a feature, then the tutor would verbally draw his attention to the fact that the construction was not completed. For example, if he had selected pieces himself and put them together wrongly, the tutor would ask him to compare his construction with hers and to make his similar. If, however, she herself had *presented* the material for construction to the child, she would herself correct any error that resulted.

Where possible, finally, she left the child to his own devices. It was only if he stopped constructing or got into difficulty that the tutor intervened. Her aim was to let the child pace the task for himself as far as possible.

There is one remaining issue that will not concern us formally in this study but which is of some importance. The tutor, the third author of this paper but not of this paragraph, brought to the task a gentle, appreciative approach to the children. She did not so much praise them directly for their constructions or for their attention to the task, but rather created such an atmosphere of approval that the children seemed eager to complete their constructions—often, seemingly, to show her as

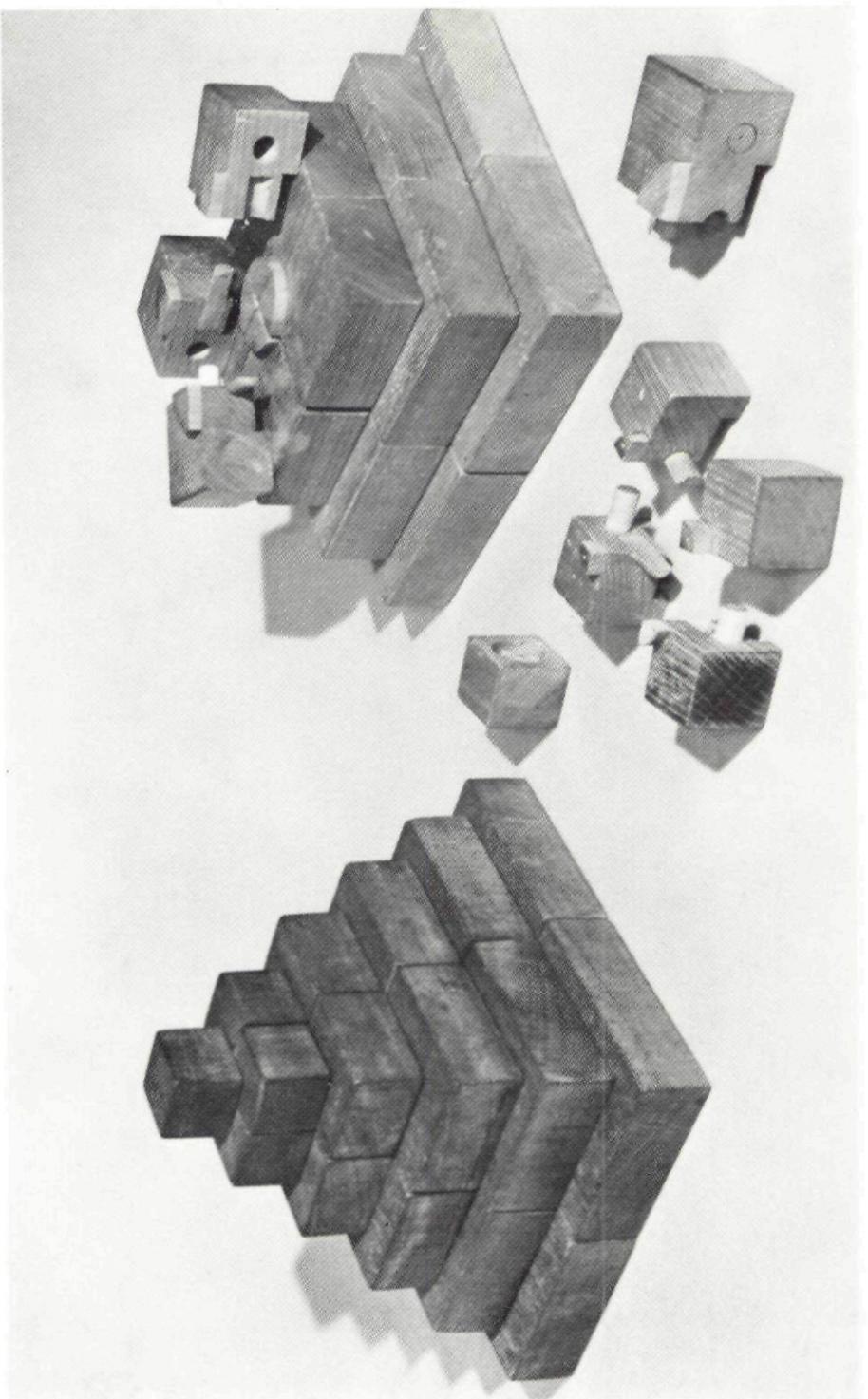


Fig. 1

well as to reach the goal *per se*. A testing procedure and a tutor create an atmosphere of encouragement or discouragement: in the present case it was the former, and the results certainly reflect it.

The matter does not stop there. The blocks are of good solid wood and the children, during the initial free period of five minutes, enjoyed playing with them freely, often constructing in the service of highly imaginative themes. They did not always enjoy giving up imaginative play for the more constrained task of building a pyramid with due regard for geometric constraints. Imaginative work during free play was often followed by a rather uninspired performance of the presented task. The tutor was a spokesman, so to speak, for the geometry of the task. As such, she may have had a dampening, if helpful, function in terms of getting the children to do *this* task. But, doubtless, the behaviour we shall be describing in the following section reflects the nature of the task for which the tutor was an adherent. Yet, the same limitation may beset any tutor dedicated to a particular outcome.

#### *System of scoring*

At any point in time, the child could either be manipulating separate pieces which he was seeking to assemble, or assemblies of pieces previously made up. The assembly operations were further subdivided into two categories: assisted, in which the tutor either presented or specifically indicated the materials for assembly, and unassisted, where the child himself selected material. In both cases, the constructions created might or might not meet all task constraints. Where they did not—a mismatch—we noted whether the child rejected them, or simply laid them down as assembled. Similarly, when the child picked up and disassembled previous constructions, he might or might not go on to reassemble them. This too was noted.

We noted every intervention by the tutor. These were classified into one of three categories: (a) direct assistance, already defined above, (b) a verbal error prompt, which characteristically took the form, "Does this (a mismatched construction) look like this (a matched one)?", and (c) a straightforward verbal attempt to get the child to make more constructions, "Can you make any more like this?" In each case, we scored the child's subsequent behaviour into the above categories.

#### *Interscorer reliability*

Two scorers, working independently, achieved 94% agreement on a pool of 594 events scored directly from video-tape.

#### *Observations on tutorials*

Whenever a child picked up blocks and put them together or when he selected previous constructions and took them apart, the act was scored. Total number of acts were roughly similar for all ages. The fours performed a median 41, the threes 39, and the fives 32. The difference between fours and fives approaches, but does not achieve, significance ( $U = 26, p < 0.1$ ). In terms of overall task activity, then, there were no significant differences between groups. However, the composition of these activities differed markedly from age group to age group.

It will come as no surprise that older children did better in the tasks. The older children produced a larger number of correct constructions in which they actually

put self-made pieces of the puzzle together correctly themselves. The ratio of incorrect to correct solutions progressing from 9 : 0 to 2 : 8 to 1 : 2 for the three age groups. Or note that it takes 15 acts of pair construction to make a correct pyramid, and that more than 75% of these acts were unassisted among the 5-yr-olds, in contrast to 50% and 10% among the fours and threes respectively.

None of the 3-yr-olds could put four blocks together correctly, while all the 4- and 5-yr-olds did so at least once. Older children frequently picked up matching pieces for construction with no prior "trial and error", a median of seven such "quick" constructions being made by each of them, in contrast to three per child at four years and less than one per child for the youngest group (5 yr vs 4 yr,  $U = 12$ ,  $p < 0.02$ ; 4 yr vs 3 yr,  $U = 10$ ,  $p < 0.002$ ). Increasing age, then, is marked not only by success but by the emergence of more complex, interlocking sequences of operations and by the development of more accurate, intuitive techniques of fitting blocks together.

Consider now the issue of recognition and production. The youngest children *took apart* almost as many constructions as they had put together (a median of 13·0) while the older children were much less likely to "deconstruct" their assemblies (the 4-yr-olds taking apart a median 5·0, and the 5-yr-olds a median 4·0). But note that when a 3-yr-old took up and disassembled a *correct* construction he put it back together again two-thirds of the time on average (without any intervention by the tutor), the performance suggesting an appreciation of the fitness of the original. In contrast, having picked up an *incorrect* construction he would restore it only 14% of the time. In fact, not one 3-yr-old reassembled his incorrect constructions more frequently than his correct ones. More important still was the finding that the 3-yr-olds were just as sensitive as the 4-yr-olds to the difference between acceptable and unacceptable constructions. The two were equally likely to reassemble appropriate constructions and to leave scattered those that had been inappropriately constructed. Thus, although the youngest children were far inferior to the middle group when it came to *constructing* appropriate assemblies, they were just as adept at *recognizing* an appropriate one when they encountered it. The oldest children had, of course, become more sophisticated still, reconstructing some nine out of ten correct constructions they had disassembled and only two in ten of the incorrect ones that they had disassembled—but the difference is not very great between them and the younger groups.

This result surely suggests that, as noted, comprehension precedes production. The 3-yr-old *recognizes* what is appropriate before he can readily produce a sequence of operations to achieve it by his own actions. It is easier for him to recognize what "looks right" than to carry out a program of action to produce it.

#### *The tutorial relationship*

Obviously, the younger children need help more. For 3-yr-olds the proportion of totally unassisted constructions is 64·5%, for the 4-yr-olds 79·3%, and for the 5-yr-olds, 87·5%. The median instances per child of constructions carried out with pieces proffered by the tutor, as compared to self-selected pieces is 9·0 for the 3-yr-olds, 6·5 for the 4-yr-olds, and 3·0 for the 5-yr-olds. But it is not so much in

amount as in the kind of dependence that one finds a difference in the tutorial interaction at the three ages.

For 3-yr-olds usually ignore the tutor's suggestions, paying little heed, particularly to her verbal overtures. This is illustrated by the sharp disparity between the median figure of eleven tutor rejections by the 3-yr-olds, in contrast to virtually none by the older children who were plainly ready to accept tutoring. This means that *vis-à-vis* the 3-yr-old the tutor has the initial task of *enlisting the child as a tutoring partner*. With the youngest ones, the tutor is principally concerned with luring them into the task either by demonstrating it or providing tempting material. Consequently, the tutor intervenes directly twice as often with the 3-yr-olds than with the 4-yr-olds, and four times more often than with the eldest group (see Tables 1 and 2). The tutor, then, is both intervening more and being ignored more when working with 3-yr-olds than with older children.

TABLE 1. MEDIAN INSTANCES OF DIRECT INTERVENTIONS, VERBAL CORRECTIONS AND GENERAL VERBAL DIRECTIONS (REMINDING SUBJECTS OF TASK REQUIREMENTS)

	Age 3	Age 4	Age 5
Direct intervention (Showing)	12.0	6.0	3.0
Verbal correction (Telling)	3.0	5.0	3.5
Verbal direction and reminder (Telling)	5.0	8.0	3.0
Total verbal intervention	8.0	13.0	7.5
Total help received	20.0	19.0	10.5
show	12.0	6.0	3.0
Ratio: show tell	$\frac{12.0}{8.0} = 1.5$	$\frac{6.0}{13.0} = 0.46$	$\frac{3.0}{7.5} = 0.40$

#### Total help received

The 5-yr-olds received significantly less help than both the 4-yr-olds ( $U = 22$ ,  $p < 0.05$ ) and the 3-yr-olds ( $U = 23$ ,  $p < 0.05$ ). The 3- and 4-yr-olds did not differ significantly.

#### Ratio of "showing" to "telling"

Both the 5-yr-olds ( $U = 5$ ,  $p < 0.002$ ) and the 4-yr-olds ( $U = 6$ ,  $p < 0.002$ ) received a significantly higher proportion of verbal assistance than the 3-yr-olds; 4- and 5-yr-olds did not differ in this respect.

TABLE 2. RELATIVE SUCCESSES OF EACH AGE GROUP WITH  
"SHOWING" AND "TELLING"

	Age 3	Age 4	Age 5
Showing succeeds	40%	63%	80%
Telling succeeds	18%	40%	57%

The predominant mode of interaction between tutor and the 4-yr-old tutee has become verbal, and the principal form of that verbal interaction is a combination of reminding the child of the task requirements and correcting his efforts as he seeks to carry on. So while we can say that the tutor acts principally as a lure to the youngest children, she acts more as a verbal prodder and corrector for the 4-yr-olds. The

number of direct interventions drops by half from the 3- to the 4-yr-olds. Note, however, that the sum of demonstrations, corrections, and directions is about equal for the 3- and 4-yr-olds, though the balance has shifted (Tables 1 and 2).

When we come to the 5-yr-olds, the median number of tutorial interventions per pupil drops again by half. Qualitatively speaking the best way of characterizing the tutor of the 5-yr-olds is principally as a confirmor or checker of constructions, the children now having firmly in mind the nature of the task.

In a word, the youngest children, although capable of recognizing the properties of a correct solution, had to be induced to try the task to learn through recognition of correct solutions. The tutor's role was to stimulate and to keep the goal before the child's eyes—not easy since the children had other notions of what could be done with the blocks. With the 4-yr-olds, already activated to construct, the tutor's task was more to help them recognize, usually by verbal marking, the nature of the discrepancy that existed between their attempted constructions and what was required by the task. It is this that shifts the balance from showing to telling as one goes from 3 to 4 yr. The 5-yr-old has recourse to the tutor only when he is experiencing difficulty or checking out a construction. The tutorial function, thus, withers away. Indeed, a tutor would be superfluous for a 6-yr-old.

It is in this sense that we may speak of a scaffolding function. Well executed scaffolding begins by luring the child into actions that produce recognizable-for-him solutions. Once that is achieved, the tutor can interpret discrepancies to the child. Finally, the tutor stands in a confirmatory role until the tutee is checked out to fly on his own. It is summed up in Table 3, where we see the number of acts the child can sustain between tutorial interventions rising steadily with age and experience.

TABLE 3. RELATIVE FREQUENCY OF INTERVENTIONS BY THE TUTOR EXPRESSED AS INTERVENTIONS PER NUMBER OF CONSTRUCTION OPERATIONS (BOTH ASSISTED AND UNASSISTED) PERFORMANCE BY EACH CHILD

	Age		
	3	4	5
Total construction operations	262	352	280
Total interventions	201	198	112
Operations per intervention	1.3	1.8	2.5

The 5-yr-olds performed significantly more operations per intervention than the 4-yr-olds ( $U = 16, p < 0.02$ ) who performed more than the 3-yr-olds ( $U = 10, p < 0.002$ ).

#### ANALYSIS OF TUTORING

Did the tutor manage to follow the pre-set rules? In 478 opportunities she conformed 86% of the time. She did so most frequently with the youngest children (92%) and less frequently with the 4-yr-olds (81%;  $\chi^2 = 9.1, p < 0.01$ ). With the 5-yr-olds, her behaviour fell mid-way (86%) though the difference between this group and the others was not statistically significant.

The majority of her "errors" with the 4-yr-olds was due to a tendency to offer more help than allowed by the rules (27 out of 36 cases). A closer inspection of the

contexts in which she "transgressed" reveals an interesting consistency. When, for example, she offered a block rather than asking the child to find one, she would invariably transgress in this way when the particular child had recently failed several times to follow or understand a more difficult type of instruction. She appeared to be changing the rules to take account of larger segments of behaviour than written into the "rules".

The fact that she committed most violations with the middle group suggests an interesting observation regarding the tutorial process. As we have already seen, the tutor's role with the youngest children was largely one of task induction. The child seldom moved more than one "step" away from the tutor in terms of constructive activity. She might provide him with material for construction which he would probably then assemble, but having done so, the odds were that he would not attempt anything more. In short, though she might have difficulty getting the 3-yr-old started and keeping his attention on the task she was seldom left in doubt as to what the child had done in response to her instructions. With the 5-yr-olds too, her task was relatively straightforward. The child soon learned the task constraints and conducted his efforts in an appropriate serial order. But, the "try it and see" behaviour of the middle group was much harder to interpret. With the 4-yr-olds, then, the tutor is faced with a great deal of relatively unstructured behaviour from a child who *initiates* most of the task activity himself. These are the ones most difficult to accommodate within a fixed set of tutorial rules.

This result leads on to the conjecture as to whether formal programmes of "individualized" teaching may be most difficult to realize at the most critical point—the mid-phase of learning. Given the "disordered" structure of this mid-phase one cannot always know that a child is in fact simply ignoring a suggestion, whether he is systematically misunderstanding it or what. To the extent that the learner is at sea, so too is the tutor, who faces difficulties in interpreting responses appropriately. Problem-solving activity often has a deep structure that may not be apparent, until a long sequence in process is near completion. The tutor often cannot recognize hypotheses underlying long sequences and in the "middle phase" there are often too many complexities for either man or machine programmes to take into account.

Where the human tutor excels or errs, of course, is in being able to generate hypotheses about the learner's hypotheses and often to converge on the learner's interpretation. It is in this sense that the tutor's theory of the learner is so crucial to the transactional nature of tutoring. If a machine programme is to be effective, it too would have to be capable of generating hypotheses in a comparable way. In tutoring, moreover, effectiveness depends not only upon the tutor and tutee modifying their behaviour over time to fit the perceived requirements and/or suggestions of the other. The effective tutor must have at least two theoretical models to which he must attend. One is a theory of the task or problem and how it may be completed. The other is a theory of the performance characteristics of his tutee. Without both of these, he can neither generate feedback nor devise situations in which his feedback will be more appropriate for *this* tutee in *this* task at *this* point in task mastery. The actual pattern of effective instruction, then, will be both *task* and *tutee* dependent, the requirements of the tutorial being *generated* by the interaction of the tutor's two theories.

### *The "scaffolding" process*

We may now return to the beginning of the discussion. Several functions of tutoring—"scaffolding functions"—were hinted at in the introduction. We can now elaborate more generally upon their relation to a theory of instruction. What can be said about the function of the tutor as observed in this study?

1. *Recruitment.* The tutor's first and obvious task is to enlist the problem solver's interest in and adherence to the requirements of the task. In the present case, this often involved getting the children not only interested, but weaned from initial imaginative play with the blocks.

2. *Reduction in degrees of freedom.* This involves simplifying the task by reducing the number of constituent acts required to reach solution. It was N. Bernstein (1967) who first pointed to the importance of reducing the alternative movements during skill acquisition as an essential to regulating feedback so that it could be used for correction. In the present instances it involved reducing the size of the task to the level where the learner could recognize whether or not he had achieved a "fit" with task requirements. In effect, the "scaffolding" tutor fills in the rest and lets the learner perfect the component sub-routines that he can manage.

3. *Direction maintenance.* Learners lag and regress to other aims, given limits in their interests and capacities. The tutor has the role of keeping them in pursuit of a particular objective. Partly it involves keeping the child "in the field" and partly a deployment of zest and sympathy to keep him motivated. The children often made their constructions in order to show them to the tutor. In time, the activity itself became the goal—but even then, the older children often checked back.

One other aspect of direction maintenance is worth mention. Action, of course, tends to follow the line of previous success. There were instances, for example when subjects would work successfully (and apparently endlessly) on constructing pairs, rather than moving on from this success at a simpler level to trying out a more complex task—like the construction of a flat quadruple. Past success served to distract from the ultimate goal. The effective tutor also maintains direction by making it worthwhile for the learner to risk a next step.

4. *Marking critical features.* A tutor by a variety of means marks or accentuates certain features of the task that are relevant. His marking provides information about the discrepancy between what the child has produced and what he would recognize as a correct production. His task is to interpret discrepancies.

5. *Frustration control.* There should be some such maxim as "Problem solving should be less dangerous or stressful with a tutor than without". Whether this is accomplished by "face saving" for errors or by exploiting the learner's "wish to please" or by other means, is of only minor importance. The major risk is in creating too much dependency on the tutor.

6. *Demonstration.* Demonstrating or "modelling" solutions to a task, when closely observed, involves considerably more than simply performing in the presence of the tutee. It often involves an "idealization" of the act to be performed and it may involve completion or even explication of a solution already partially executed by the tutee himself. In this sense, the tutor is "imitating" in idealized form an attempted solution tried (or assumed to be tried) by the tutee in the expectation that the learner will then "imitate" it back in a more appropriate form.

In the introduction we said a few words about the subtlety of "modelling" an act that is to be "imitated". In fact, observed instances of "imitation" were all of a kind as to suggest that the only acts that children imitate are those they can already do fairly well. Typical was the following incident, involving a 4-yr-old.

Tutor, noting that subject is constructing pairs quite easily, now takes two pairs and fits them together as a quadruple. Subject then takes the quadruple, disassembles it into two pairs, and hands these back to tutor. This in turn leads the tutor to a highly idealized version of constructing the quadruple: she now does it slowly and carefully, in contrast to a swift and casual construction of the constituent pairs. The child does not follow suit.

In fact, the study taught us little about imitation save that its occurrence depends upon the child's prior comprehension of the place of the act in the task. In all instances observed with these 30 children, there was not a single instance of what might be called "blind matching behaviour".

#### SUMMARY

3-, 4-, and 5-yr-olds were tutored in the task of constructing a pyramid from complex, interlocking constituent blocks. The results indicate some of the properties of an interactive system of exchange in which the tutor operates with an implicit theory of the learner's acts in order to recruit his attention, reduces degrees of freedom in the task to manageable limits, maintains "direction" in the problem solving, marks critical features, controls frustration and demonstrates solutions when the learner can recognize them. The significance of the findings for instruction in general is considered.

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