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ABSTRACT

Several curricula for early childhood education rely heavily upon Piagetian theory, based on the reasoning that children who have acquired operational structures of thought one or two years earlier than their peers are differently oriented to instruction than their more recently conserving peers. This paper emphasizes that there is no evidence that specific instruction for operational concepts can close the achievement gap that has been shown to exist between early and late conservers. Results of research with kindergarten children followed through third grade indicated that direct instruction in conservation does not bridge the gap in achievement between early and late achievers. A discussion of implications of Piaget's theory for education is also presented. The author urges educators to come to grips with the goals and purposes of education before trying some of the many "innovations". (SET)

IS "SCHOOL ACHIEVEMENT" ENHANCED BY TEACHING CHILDREN OPERATIONAL CONCEPTS?

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There have been a number of studies that have reported significant relationships between scores on Piagetian type tasks and measures of school achievement (Fryberg, 1966; Dudek, Lester, Goldberg, and Dyer, 1969; Miller, Stephens and McLaughlin, 1969; and Kaufman and Kaufman, 1972). These findings attest to the effectiveness of Piagetian measures as predictors of school achievement but they say nothing of the pedagogic value of Piaget's theory. It would be a mistake to assume that because success on operational tasks are positively related to achievement that teaching children operational concepts would improve their achievement. The mistake, of course, is to infer causality from a correlation. IQ scores, for example, predict achievement in school but school curricula are not built around block designs, picture completion, or digit memory learning. In full appreciation of the fact that IQ measures are psychometric and atheoretical and that Piagetian measures are well grounded in an exhaustive theory of development, it is experimental rather than correlational research that is necessary in order to asses the pedagogic value of the theory (cf. Wohlwill, 1973).

There have been many experimental training studies derived from Piaget's theory and most of them have shown that children at certain ages can be taught certain operational concepts, particularly conservation (see Beilin, 1971, for a concise review of research in this area). However, these studies were not designed as pedagogic vehicles for the acceleration of school performance but as a means of experimentally delineating the theoretical mechanisms of stage transition. They typically did not test for the long-term effects of training (seven months at the most) nor did they test whether the effects of training transfered to such school related skills as reading, mathematics or language.

Despite the lack of emperical evidence that would support the practice of teaching children Piagetian concepts, an increasing number of educational psychologists are developing and implementing school curricula purportedly based on Piagetian concepts. Lavatelli (1970), for example, has produced a curriculum package that has been adopted by schools across the country. Her program relies heavily on the specific instruction of Piagetian concepts including conservation. The AAAS Science program (Science, A Process Approach, 1965) is another popular curriculum package that involves the direct instruction of Piagetian concepts including conservation.

The reasoning behind these efforts is that children who have acquired operational structures of thought one or two years earlier than their peers are differently oriented to instruction than their more recently conserving peers.They are able to assimilate information in a different fashion and to relate it to different types of experience. However, we have no evidence that specific instruction for operational concepts can close the achievement gap that has been shown to exist between early and later conservers. Piaget has repeatedly cautioned that the child's ability to think operationally is a reflection of underlying cognitive structures that are not readily amenable to environmental manipulation and that children who have been taught to conserve may not have generalized the logic of conservation to other areas of cognitive activity (Piaget, 1964; 1967).

It is in this climate of increasing efforts to use Piaget's theory of cognitive development as a proscriptive tool to determine what children should be taught in schools that I sought evidence that would attest to this practice. I therefore want to spend a considerable portion of my presentation today discussing some recent findings that I believe seriously question the value of using Piaget's theory to design the contents of school curricula. I will not dwell on the matter that Piaget himself disavows any association with proscribing <u>what</u> children should be taught (Piaget, 1971). Later, I will briefly describe how his theory is useful in answering questions concerning <u>how</u> children should be taught.

In 1969 I reported the findings of a conservation training study based on white, middle-class, kindergarten children (mean age was 5 years, 10 months; Bearison, 1969). This study followed the basic experimental and control group for posttest comparisons. As part of the pretest procedures of the study, all of the subjects were tested for their ability to conserve the following properties: discontinuous area, continuous area, mass, length, number, discontinuous quantity and continuous (liquid) quantity[2]. The format of these tests followed those used by Piaget and his colleagues in Geneva.

On the basis of pretest scores, a subject who failed every trial of every conservation test were designated as nonconservers. Subjects who had one or more correct responses were considered to be early conservers, although most of the early conservers were able to conserve more than a single property. Half of the nonconservers were randomly selected for training and this group will be referred to as the trained conservers, while the other half constituted the control group.

Training focused on the conservation of liquid quantity. Details of the training procedures can be had from the original article (Bearison, 1969). The effects of training were quite impressive. One month posttest data showed that approximately half of the trained subjects were able to conserve not only continuous quantity but all of the other properties as well. Three-fourths of the subjects were able to conserve at least continuous quantity. The types of explanations offered by the trained conservers were the same as those offered by the early conservers. Seven months after training the posttest performance of the trained conservers was still significantly better than the controls.

When these subjects entered the third grade they were group administered the Otis-Lenon Intelligence Test and the Stanford Achievement Test (SAT). The Otis-Lenon is a standardized paper and pencil intelligence test that yields an IQ score and the SAT is a standardized measure of school achievement. For those of you who are not familiar with the format of the SAT, it consists of the following subtests: (1) Word meaning, the subject is asked to select the correct words to complete sentences; (2) Paragraph meaning, the subject is asked to select the correct words that have been omitted from paragraphs; (3) Science and social studies, a science vocabulary test in which the subject is asked to select the correct words that fit verbal definitions; (4) Spelling, a dictation type spelling test; (5) Language, a test of grammar and punctuation in which the subject is asked to select the correct words according to rules of capitalization, simple punctuation, and verb tense; (6) Arithmetic computation, a free-response test of the subject's ability to add, subtract, multiply, and divide; and (7) Arithmetic concepts, a diverse test of skills including reading from a clock, reading calendars, reading a bar graph, completing numerical series and solving simple verbal problems.

There was about a 40 per cent rate of attrition among subjects from the time they were in kindergarten and were trained to the time they entered the third grade. There were 12 early conservers, 10 trained conservers and 12 controls. The subjects who remained in the sample pool and those who were lost did not differ in terms of their posttest performance.

This particular training study was replicated in detail by Louis Fusaro (1969) who was a graduate student at Clark at the same time that I was also a graduate student there. He used subjects from the same school district as I had. The training effects he reported matched my own and his rate of attrition was similar to mine. I therefore increased the sample size by combining the data from subjects in his study with those from my own. The resultant group totals were: 26 early conservers, 17 trained conservers, and 18 controls[3].

Now for the results--the data were analyzed in a one-way multivariate analysis on covariance (Tatsuoka, 1971). I will first describe the basic outline of this particular type of analysis. The dependent variables were the eight SAT subtest scores and IQ was the covariate. The treatment factors were early conservers, trained conservers and controls. An F-ratio for the first through second roots was computed for the treatment factors. This F provided an exact test of the overall differences on the dependent variable set with respect to the treatment levels. In addition to the overall F-ratio, a multiple group discriminant analysis was computed for the first treatment dimension. The discriminant analysis is based on the linear combination (canonical variate) of the dependent variables weighted so that the between-group to within-group variance is maximized. This analysis provides for maximum discrimination among the treatment groups. A second F-ratio was computed for the second root to determine if there were any significant differences remaining among the treatment groups after accounting for the first canonical variate.

Now, the specific findings--as would be expected, the mean IQ for the early conservers was considerably higher than for either the trained conservers or the controls (120, 108 and 106 respectively). The analysis was therefore performed on that part of the dependent variable set not accounted for by the covariate.

There was a significant F on the overall differences among the treatment groups ($F=2.12$, $df.=16, 102$, $p<.05$). Differences among the treatment groups were not significant after deletion of the first canonical variate. We can therefore conclude that there was overall significance between the three treatment groups and that the groups differed on only one orthogonal dimension. We will now examine the nature of these differences.

Insert Table 1 about here

Using the multiple group discriminant analysis, a set of discriminant function weights was obtained for the significant canonical variate. These weights define a dimension along which the levels of a factor are maximally discriminated. The results that appear in the upper portion of Table 1 are the discriminant function weights for the dependent variable set. These discriminant function weights will be used to describe the orthogonal dimension that discriminates among the treatment levels somewhat like a factor loading is used to interpret a factor. Examination of these weights shows that the discrimination among the treatment groups was mostly due to differences in scores on the following SAT subtests: Word meaning, Paragraph meaning, Word study skills, Arithmetic computation, and Arithmetic concepts. Scores on Spelling, Language, and Science and social studies discriminated the least among the treatment groups.

The product of the discriminate function weights and the standardized mean subtest scores (adjusted for IQ) yielded a mean discriminant score for each treatment group. These mean discriminant scores appear in the lower portion of Table 1. These values are centered about zero (the grand discriminant score having been removed) and show the relative placement of each treatment level on the discriminant dimension. As can be seen, the early conservers, received the highest mean discriminant score followed in order by the trained conservers and control subjects.

In discussing these findings, I want to first consider the differences in the mean discriminant scores between the group of early conservers and the control group. The magnitude of this difference confirms what others have already reported in terms of a high relationship between conservation and school achievement (Fryberg, 1966; Dudek, Lester, Goldberg, & Dyer, 1969; Miller, Stephens, & McLaughlin, 1969; and Kaufman & Kaufman, 1972). Conservation measures are effective predictors of school achievement, even with IQ scores controlled.

Looking at the discriminant function weights assigned to each of the SAT subtests (upper portion of Table 1) we can see that the particular areas of achievement in which prediction is greatest are fields of achievement reflected in scores on Word study skills, Word meaning, Paragraph meaning, Arithmetic computation and Arithmetic concepts. These subtests specifically tap verbal abilities (excluding vocabulary and grammar) and mathematical ability. Conservation attainment is not an effective predictor of success on the Spelling, Science and social studies, and Language subtests of the SAT. These latter subtests are essentially measures of spelling, vocabulary, grammar, and punctuation (although the Language subtest does not discriminate between scores from items on punctuation and those on grammar). That conservation attainment should be related to some areas of achievement and not others is consistent with the fundamental distinction that Piaget makes between the operative and the figurative aspects of knowing (Piaget, 1951). Figurative aspects have to do with the representation of knowledge while operations refer to the transformation of objects and events (or their symbolic equivalents) into schemes of knowing.

For Piaget, intelligence consists of operations which, according to different stages of development, define different forms of mental activity. The objects and products of intellectual activity are represented by figurations but the figurations do not bear directly on the act of intelligence (see Furth, 1969, for a lucid account of this distinction). Skills such as spelling, vocabulary, and punctuation have to do with the encoding and decoding of verbal symbols, what Piaget refers to as the "semiotic" and communicative function of thought (Piaget & Inhelder, 1966), but they do not reflect operational intelligence per se. It is therefore fitting that a test for conservation, as a measure of the presence of concrete operations in the child, would predict essentially the operational aspects of school achievement and not the figurative aspects.

I now want to discuss the findings that bear upon the primary purpose of my presentation--whether children trained to conserve a year or two before they would show evidence of conservation on their own compare favorably in terms of school achievement with children who are naturally preconscious conservers. If we compare the differences in the mean discriminant scores of the early conservers and the controls, and the trained conservers and the controls we see that the higher level of achievement that come from being able to think operationally one or two years prior to the time when most children enter the period of operational thought cannot be attained through direct instruction of operational concepts such as conservation. Although conservation training appears to result in the inducement of underlying structural reorganization it is more likely that the trained conserver has learned the logical basis of conservation without generalizing operational thought to other fields of cognitive acitvity.

As in the case with any training study that does not fully meet the criteria that are set for it, the question arises whether it is the particular training procedure that is at fault and whether another procedure might effect the structural reorginization that would allow children to assimilate school instruction at a developmentally higher level. Although we cannot directly respond to this question, (one never can in such cases) it should be noted that our particular conservation training procedure was highly successful in relation to other conservation training procedures and on the basis of Piaget's own criteria for assessing the child's ability to conserve. Seven months after training approximately three-fourths of the trained conservers compared to approximately one-third of the control subjects were able to conserve seven different substances in terms of correct quantitative judgments and, more significantly, they were able to offer a justification for their judgments. Few other training procedures have produced as impressive results and although I'm not certain that better conservation training programs cannot be developed, I believe that the attempt to enhance children's school achievement by trying to devise better training procedures or implementing existing ones into the school curriculum is an exercise in futility. The basic reason for this is that although it is possible for psychologists to accelerate development within a narrow range by providing children with special types of experience, we cannot effect the broad based developmental changes that comes from the exceedingly complex interaction of factors relating to maturation, experience, social transmission, and equilibration acting together as forces of growth. In this sense, learning is subordinate to development and, contrary to behaviorist theories, it cannot account for development. The learning that takes place in conservation training is not the same as development because it does not provide the child with the cognitive structures to which instruction in other related fields can be assimilated.

If training on specific operational concepts is not of value in promoting school acievement in young children, the question remains as to what relevance Piaget's theory can have for educators. Although Piaget did not develop his theory with education in mind, it does have considerable significance and relevance for the educator and I would like to conclude this talk in the context of this issue.

Piaget maintains that the acquisition of knowledge comes about through qualitatively different cognitive modalities at different levels of development. This is a critical point for instructors because it proscribes a match between the form of instruction and the child's level of development. In order to achieve this match at the primary school level, children must be allowed a maximum of activity on their own because for them knowledge is created through their concrete actions. This implies a major redefinition of the teacher's role in the classroom. Rather than attempting to transmute a given body of knowledge to children, the teacher presents the child with problems and the resources which would allow him to actively structure a solution on his own terms. This is not the same thing as questioning the child and seeing if he can literally second guess the teacher. Teachers themselves must become proficient in Piaget's clinical method so that they can allow the child to develop his own modes of spontaneous inquiry with little interference from adult authorities. It is not until the child is about 12 or 13 years that he is capable of benefiting from the traditional mode of formal education.

Piaget has some very definite opinions of what the goals of education should be and his opinions follow directly from his theory. According to Piagét, "The principle goal of education is to create men (and women) who are capable of doing new things, not simply of repeating what other generations have done....The second goal of education is to form minds which can be critical, can verify, and not accept everything they are offered (1964, p.5)." It is questionable whether our communities are ready to nurture the development of such "free thinkers" it it means sacrificing conformity to cultural standards and beliefs. However, the ultimate goals of our educational institutions will shape the ways in which they are implemented. It is therefore a mistake to try to implement changes that stem from Piaget's theory without explicitly coming to grips with the fundamental purpose of education as Piaget sees it. I want to illustrate this point by describing a particular school I recently visited.

This school, at the urging of its science department, adopted the AAAS science program and, within the proscriptions of that program, children learning sciences were encouraged to ask themselves questions, make their own observations, and to be wary of pat answers. Their other areas of instruction, however, followed the time honored methods of traditional school instruction. The results of this type of instructional duality was that the children were never able to capture the spirit of inquiry which the AAAS program was intended to foster nor were they so willing to accept the standardized procedures of traditional instruction. When I spoke with the teachers about this, they said that the children should be able to readily adapt to both systems of instruction because the different systems were concerned with different content areas. They believed that the children would come to expect one mode of instruction when learning science and another mode when learning other subjects. This, of course, contradicts Piaget's most basic tenet concerning the way in which the structuration of knowledge proceeds with development, and I think that these children would have been better off with one form of instruction or the other but certainly not both.

For Piaget the content of inquiry and instruction is subordinate to its form so that although educators find it useful to divide the curriculum into subject categories, children do not. The true value of Piaget's theory for educators is that it proscribes a method of fostering inquiry in the child that literally transcends specific content areas. If the content of instruction is less important than its form then it shouldn't make much difference whether children are taught basic academic skills such as reading, writing, mathematics and language in the context of science, social studies, or art history. What would make a difference is what subject areas are interesting to each child with full appreciation that what interests one child will not interest another child. When the subject matter is interesting to the child, the use of external reinforcements in learning can be minimized and, more significantly, the likelihood of his retaining what he has learned and his ability to relate it to other contexts is enhanced.

If there is only one message that I could communicate to educators, it is that there is today a pressing need for them to come to grips with the goals and purpose of education before making stabs at academic "innovation" in the name of Piaget or anyone else.

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Footnotes

1. Paper presented at the Fourth Invitational Interdisciplinary Seminar on Piagetian Theory and its Implications for the Helping Professions, Los Angeles, February, 1974. Authors address: The Graduate Center, City University of New York, 33 West 42nd Street, New York, New York 10036.

2. All subjects were also tested for their ability to count and their comprehension of the terms "more" and "same".

3. Fusaro used two different conservation training procedures on two different groups of subjects. Only the data from subjects who were trained to Bearison's procedure and the control subjects were used in the present study.

TABLE 1.

Discriminant Analysis for Main Effects
Due to Treatment

	SAT Subtests							
	Word Meang.	Parag. Meang.	Sci.&Soc. Studies	Spell.	Word St. Skills	Lang.	Arith. Comp.	Arith. Conc.
Discriminant Function Weights	.31	.28	.14	.01	.58	.02	.32	.55

	Treatment Groups		
	Early Conservers	Trained Conservers	Controls
Mean Discriminant Scores	1.46	-.35	-1.09