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Role of Task-related Factors in Assessing Young Children's Logical Ability in Class Inclusion

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One of the ways in which we assess children's logical competence is to ask them questions. This is based on two rather weak assumptions — first, that they understand these questions in the same way adults do and secondly, that logical operations are required to answer these questions. However, since at the start, the child does not know the intentions behind our question, he has to consider the form in which the question is posed and use whatever contextual cues or clues are available to make a correct inference. Relevant information may or may not be contained in the question or the external context. Sometimes, both question and context contain these information, and variation in either can lead to a correct or incorrect answer, independent of the logical abilities theoretically being assessed.

The purpose of this article is to examine how perceptual, semantic, referential and comparison processes are affected by contextual variation in a cognitive development task. The central thesis is that logical ability cannot be assessed independently of these processes and that what develops cognitively is a broader competence than just competence in logical operations. The nature of this problem is exemplified in the steady stream of studies dealing with the Piagetian stage concept in intellectual development, and with the pre-operational to concrete-operational stage in particular.

The Piagetian model of cognitive development is a comprehensive and general theory of the growth of children's understanding of the world around them. Its main premise is that in the course of development, the child passes through an invariant sequence of stages, each of which represents a unique level of analysis, internal mental organization and understanding of environmental information and events. In the Piagetian system, the pre-operational stage, which corresponds approximately to the period between two and six years, is marked by egocentric and transductive qualities. This unique stage of development is also inferred from the absence of certain cognitive operations such as conservation, transitivity, seriation and class inclusion. These operations are based on tasks which required the child to comprehend language related to relative and absolute quantity (e.g. more, less, same, larger than, smaller than). Successful performance on the task is indicated by the production of some appropriate verbal responses or explanation by the child. The child's performance on these tasks is thought of as reflecting directly on the child's competence without considering the various situational or contextual factors involved in the specific tasks (Carmi, 1981).

There is evidence suggesting that task-specific variables as well as cognitive capacities may be important factors involved in children's failure to demonstrate proficiency on traditional cognitive tasks (Siegel, 1978). Donaldson (1978) has demonstrated that if the cognitive tasks used to assess performance are incongruent with everyday experiences, then these tasks do not make much sense to the young child. The role of familiarity, language and other subtle factors is also convincingly demonstrated by Gelman (1978). A recent study done by Thomas and Fam (1984) indicated a methodological problem in linguistic communication on a series of cognitive developmental tasks. This is of special significance in a multi-lingual society like Singapore. With regard to the language typically used in these cognitive tasks, there is a huge body of evidence showing significant deficiencies in the young child's understanding of relational terminology. With young children, linguistic aspects of assessment are particularly important. My own experience in the current Bernard van Leer project study on the cognitive development of pre-schoolers in Singapore has

shown that 3 to 6-year-old children could not comprehend terminology such as more, less same and longer. Also, children in this age range often make errors indicating an incomplete understanding of words such as big, small and little. If there is some reason to suspect a lack of linguistic competence on the child's part, then failures on these tasks may be due to either his lack of the cognitive operation being tested or his inability to comprehend and produce the required language or of course both.

The particular task that will be examined in this paper is a problem of critical importance within Piaget's theory, namely class inclusion. Questions and hypotheses have been formulated concerning the relation between the cognitive abilities of children necessary to complete this task successfully and the particulary contextual factors involved in the task. Class inclusion is the logical and critical end point in the development of young children's classification behaviour (Kofsky 1966). For Piaget, the concept of classes and relationships among them form the building blocks of intellectual thought. Thus, the acquisition of this concept is a skill of major significance. The ability to compare a superordinate class with its subordinate classes and to perform reversible operations on quantitative classes is supposed to mark the transition from pre-operational to concrete operational thought (Trabasso *et al* 1978). Piaget concluded that class inclusion competence is lacking when children resort to a comparison of the two subclasses.

Theoretically, there has been little argument about the class inclusion logical operation. However, a considerable number of experiments have been done on variants of the class inclusion task itself (Wohlwill, 1968; Tatarsky, 1974). These and later studies have shown conflicting results. Task manipulations which have been replicated or modified can or cannot facilitate class inclusion performance. It appears that the typical class inclusion task may be tapping not only inclusion competence but other task-related abilities as well. It also suggests that class inclusion performance can be influenced by different degrees of task variation — an issue which Piaget did not investigate directly. Reviews by Winer (1980) and Trasbasso, Isen, Delecki, McLanahan, Riley and Tucker (1978) have all indicated that large differences in children's behaviour can result from a wide variety of task manipulations of the standard class inclusion task. Several studies have indicated the significance of more than one effect but they do not examine interaction effects between certain kinds of task variables.

Use of Redundant Cues: Perceptual Manipulation

In most class inclusion problems, the superordinate class is more abstract than its subclasses. For example, 'cats' and 'dogs' might be the major and minor subclasses, and 'pets' or 'animals' the superordinate class. Such superordinate classes do not suggest clear perceptual representations, but require a degree of abstraction as a basis of classification. Part of the apparent difficulty with class inclusion problems may be due to the abstract nature of the superordinate relative to the subclasses. The subclasses, when displayed, are clearly visible and concrete and are in this way better defined than the superordinate class. 'Dogs' and 'cats' are more easily concretely represented than the concept of 'animals'. Hence, if the superordinate class can in some way be made perceptually identifiable or more salient, class inclusion performance may be enhanced.

Wilkinson's (1976) design was one of the clearest and most direct manipulations of the perceptual features of the superordinate class. He modified the salience of the superordinate class by referring to distinctive perceptual features of that class. The class inclusion problem incorporated distinctive features of both the subclass and the superordinate class. For example, the children were shown line drawings of three adult figures, all of whom had a chair, two of the adults were women with a picnic basket and one was a man without a picnic basket. The standard class inclusion question was: 'Are there more mothers (A) or more grown ups (B)?' and the distinctive feature question was: 'Are there more grown ups who have a picnic basket (A) or more grown ups who have a chair (B)?' With the standard question, children gave the correct answer 23% of the time but when specific identifying features were used for the classes, the children were correct 60% of the time.

This study shows one way in which redundant cues can facilitate class inclusion performance. However, it raises the question whether children use counting rather than semantic means to solve inclusion problems. If this is so, then children are not making a class inclusion comparison, but are simply counting and comparing two disjunctive classes. A possible interpretation is that the use of distinctive cues identifying superordinate class enables the child to see clearly which comparison is called for.

McGarrigle, Grieve and Hughes (1978) manipulated the visual cues of the superordinate class in a similar manner. Using three block plastic cows and

one white cow, all lying down, the researchers compared the standard Piagetian question 'Are there more black cows or more cows?' to the modified question 'Are there more black cows or more sleeping cows?' The average number of correct responses increased from 25% for the standard question to 43% for the altered question for children between five and seven.

Presence of an Extraneous Superordinate Class

Another perceptual manipulation used by several researchers (Wohlwill, 1966; Isen, et al, 1978) had the effect of making subclass comparison more difficult. This was done by adding a class of objects to the display unrelated to the original superordinate class. Such additional extraneous items would theoretically increase the salience of the superordinate class so that children would be likely to make the correct response. Performance was in fact improved when the additional items were used. Similary, Wohwill (1968) facilitated performance by adding a few objects that were not members of either subclass. Presumably, these additional objects allowed the child to perceptually contrast the class in question with other objects. Isen et al (1975) sought to enhance this effect by providing another superordinate class as a contrast to the one being asked about. He included transfer tests to single-class problems and found improved performance with the transfer. Evidently, perceptual cues which increase the salience of the superordinate class by the addition of an extra class, facilitate children's inclusion performance.

Use of Verbal Cues

In the class inclusion task, the child's verbal responses are frequently the only performance data available to the investigator. This being so, it is important to explore the relationship between the type of class inclusion question, verbal cues and class inclusion performance (Siegel, 1978). A number of studies have modified the class inclusion question with verbal cues, and corresponding changes in class inclusion performance have been observed.

Shipley (1979) distinguished two types of class inclusion question and demonstrated that children who failed the standard class inclusion question often improved when relevant linguistic cues were provided. The form of the standard question she used was: 'Which is more, the lemons or the fruit?' The altered question was: 'Which is more, only the lemons or all the fruit?' Hodkin (1981) reported results and an interpretation which were consistent with Shipley's studies. Hodkin used the word 'all' to modify the superordinate class. For example, her modified question form was: 'Are there more Smarties or more of all the candy?' Children three to eight years old gave more correct answers to this question than to the standard Piagetian question. The single modifier 'all' was sufficient to improve performance.

Other researchers have also noted that to a large extent, the difficulty with the class inclusion problem is a linguistic one. In particular, Shipley (1979) and Winer (1974, 1978) maintain that children fail the inclusion problem because they erroneously interpret the questions as involving mutually exclusive classes. This shows how minor changes in the spoken class inclusion question can dramatically alter the child's response. Studies have indicated that the difficulties with the class inclusion problem lie with the child's response to verbal cues as well as perceptual cues. In fact, investigators have tried to identify the separate effects of verbal and perceptual effects but have not tried to examine both effects together.

Salience of the Superordinate Class

There has been some indication that the nature of the stimuli being classified effects class inclusion performance. In Inhelder and Piaget's study, for instance, questions involving animals as the superordinate class were much more difficult than those involving flowers. Dogs, birds and insects were selected as representative subclasses for the animal (superordinate) class. It was also observed that incorrect answers for the animal class continued to be given, up to a later age than for the flower class. Inhelder and Piaget's explanation of the variable class inclusion responses was that children were more familiar with flowers than animals.

Research by Brown (1958) indicates that poor class inclusion performance may be linked to difficulty in labelling the subclasses as good exemplars of the superordinate class. Brown found that children learn to label objects which make up classes such as 'animals' in a different manner from the way in which they label objects which belong to classes such as 'flowers'. The labels learnt for the 'animals' category are invariably subclass labels like 'dog' and 'cat', whereas the label learnt for the objects in the 'flowers' category is invariably the superordinate class label itself, 'flower'. Brown argued that the child learns more specific (subclass) labels for objects which the adult expects him to distinguish but he

learns the general (superordinate class) labels for objects which he is not expected to distinguish. Thus the specificity or generality of object labels acquired by the child is a function of the discriminatory abilities expected of him by adults.

Carson and Abrahamson (1976) demonstrated that the class inclusion skills of children in grades one to four depended on the extent to which stimuli are good examples of a category. They had hypothesized that some subclass would be more representative of a larger superordinate class and would therefore be easier for children to include in a count of the larger class. For example, 'horses' and 'dogs' were considered better exemplars of the 'animal' category than 'flies' and 'bees'. When children were shown horses and dogs and asked the class inclusion question 'Are there more horses or more animals?' they performed better than when shown horses and flies or dogs or bees.

Evidence from the foregoing studies indicates that assessment of class inclusion competence depends upon the particular superordinate category selected and the relative salience that the superordinate class label has in relation to the subclass label. Therefore, the selection of the superordinate class category and the elements within the superordinate class category is critical when designing class inclusion tasks. Some of the subclass exemplars are almost always called by their superordinate labels (eg. violets are called 'flowers' and banyan is called 'tree'). The superordinate labels in these cases are therefore highly salient relative to the specific subclass names.

When we are studying class inclusion performance, we are not only assessing class inclusion competence. There are many task variations which affect children's responses to inclusion questions. To examine carefully the effects of these task requirements, class inclusion studies need to be analyzed according to predominantly perceptual, linguistic or class content manipulations. A common element inherent in all facilitative manipulations is the emphasis of the superordinate class in some way or another. This has the effect of minimizing the most common error made in class inclusion tasks, that is, subclass comparison.

Four important task manipulations have emerged as significant themselves. These have met the criteria of statistical significance, with at least one successful replication without disconfirmation and clearly stated procedures. They are:

1. adding redundant cues to the superordinate class,
2. adding an extra superordinate class to the array,
3. adding the verbal cue "all" to the superordinate class and
4. using a highly salient superordinate class label.

An investigation of these four task manipulations and their interaction, which has been seriously omitted in previous studies, will throw some light on how task variations affect class inclusion performance. In so far as perceptual and verbal manipulations can be seen as influencing the way in which information is being coded, such a study should be of value to researchers who wish to look at class inclusion closely from an information — processing point of view..

Implications For Learning And Teaching

The study of task manipulations in the class inclusion task has several general implications for learning and teaching hierarchical concepts. Besides increasing an awareness towards on understanding of classificatory behaviour of young children, similar studies have revealed that class inclusion for the young child is not an easy task. This difficulty is consistent with the findings of the Genevan investigations. Most five and six year old children are not successful in this task. According to Piaget, they are unable to think of the whole and the part simultaneously and it would follow that their ability to think of the whole-and-part of heirarchical concepts is similary limited.

One implication is clear. It is recommended that in the kindergarten and lower primary school curriculum, procedures should be developed for learning class inclusion along with the formation of hierarchical concepts. In developing these procedures, we need to determine means which are not only effective in relation to learning class inclusion, but which are also appropriate for classroom practice.

One procedure for developing class inclusion is indicated in the writer's previous finding that significantly more kindergarten children were successful on functionally or meaningfully-based class inclusion tasks. The meaning a concept has for a child is related to the modes of representation he uses in organizing his world. Bruner and Olver found that of the six-year old children who formed a genuine category or class, the majority did so on the basis of the common function concerned in all the items. Tasks containing such items appear to be much easier for young children. Therefore, it seems reasonable to suggest that the initial work in developing the principle of inclusion might be more

effectively accomplished by using functionally defined heirarchical concepts in the learning tasks.

This suggestion has one implication related to concept development in school practice. Since the use of meaningful items in classifying seems to be prevalent in young children, perhaps the experiences provided for children need to be analysed with them. The functional aspects can become the basis of classifying, and opportunities can be given for the child to classify functionally. Meaningful and functional attributes can be stressed in developing concepts.

Attention needs to be given to the structure of concepts included in the curriculum. The structure includes features such as the defining properties of the concept (*intension*), membership in the class represented by the concept (*extension*), class composition and hierarchical level. In the past the analysis of concepts used in curricular development for young children has been concerned with dimensions such as concreteness-abstractness and familiarity-unfamiliarity. These dimensions certainly still need to be considered in making decisions about the selecting of concepts for the curriculum. In addition, it is suggested here that attention to the structural dimensions of concepts will enable us to achieve greater congruence between the concepts to be formed and the child's cognitive processes. Furthermore by being aware of the structure of concepts, one can more adequately plan for assimilative and accomodative experiences.

The indication that the young child is unable to hold the whole and the part in mind simultaneously has implications for classroom practice. It would seem important for the teacher to recognise at what points the young child's cognitive processes may not be keeping up with the course of an activity concerning hierarchical concepts. For example, in working with a hierarchical concept, such as farm animals, are kindergarten children able to keep up with transitions that may occur in discussing a subclass, e.g. cows, in relation to the whole class and vice versa? Do they understand the inclusiveness of a concept such as farm animals? In other words, do they really understand that there are more farm animals than cows.? Close attention needs to be given to the cognitive requirements involved in conceptual activities designed for young primary children. Hence, the development of cognitive readiness has to be emphasized and extended more systematically into the area of concept development in the kindergarten curriculum.

Suggestions for developing cognitive readiness are implicit in the current body of research on children's cognition. In relation to hierarchical concepts, this readiness programme would need to be concerned with developments, such as:

1. multiple classification of items in the content;
2 delineation of primary and secondary classes;
3. overt awareness of the criteria governing particular classification;
4. flexibility in classifying i.e. being able to change the criterion upon which a classification is based and being able to recognized and choose among alternative ways of classifying particular elements.

This research has implications for the longstanding practice of using tasks structured to assess children's acquisition of specific conceptual abilities. It has been customary to presume that children between the ages of 5 and 10 can cope with language used in such tasks. Evidence has shown that this presumption is not warranted. Many investigations have pointed out the importance of the total situation in which a sentence is heard in determining how a child interprets that sentence. Research, however, has concentrated primarily on non-linguistic factors while the possible effects of the linguistic context and the interaction between it and non-linguistic factors in the total situation have not been studied. Task language, in addition to other situational factors, should be considered both in designing tasks to assess conceptual abilities and in interpreting the results obtained from them.

The way in which the language is used by the child is far more complex than might have been expected. It has been observed that there is considerable complexity in the child's use of language in contexts of comparison, description and discrimination. This has clear implications for the study of semantic development and linguistic comprehension. An estimate of the child's ability to correctly interpret linguistic meanings should be sensitive to the type and context of question with which we attempt to elicit responses.

One must constantly keep in mind that language does not simply involve words that name objects. Objects can be referred to in various ways, depending on the context. If we wish to understand the processes underlying the child' responses across various contexts, we must look and see how the child is using the language. Further inquiry must not only consider what motivates the pre eight-year old to use the language of standard class inclusion problems in a way different from the adult, but also

what underlies the responses of post eight-year-old children who use the language in a way similar to the adult. What underlies this change? It seems as if this will only be uncovered by an intensive longitudinal study of individual children which may be useful in attaining a more accurate account of why children may be so vulnerable to situational cues. ■

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