A selected cross-cultural study of Piaget's stage theory of cognitive development

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A selected cross-cultural study of Piaget’s stage theory of cognitive development

Abstract
The large number of research studies which have been published on the cross-cultural implications of Piaget’s cognitive development theory are extremely varied. This study attempts to classify them into three areas: sequence of cognitive development, rate of cognitive development, and the influential factors of cognitive development, in order to verify the universality of Piaget’s theory and put forward some suggestions about educational practice. The review and analysis of related literature indicates that first, the universality of the sequence of cognitive development only deals with sensorimotor and pre-operation stages rather than concrete and formal operational stages. Second, the age of acquisition of each stage criterion varies in different cultures and environment. Finally, cultural structures, type of schooling, and different environments are all influential factors in cognitive development. They are either interactive or separate in influencing cognitive function. It is these factors that create the different rate of cognitive development as well as non-universality of concrete and formal operational stages. Moreover, it is this point that suggests to us that educational practice should focus on not only the product but also the process of cognitive development.
A SELECTED CROSS-CULTURAL STUDY

OF

PIAGET'S STAGE THEORY

OF

COGNITIVE DEVELOPMENT

A Research Paper

Submitted to

The Department of Curriculum and Instruction

In Partial Fulfillment

of the Requirements for the Degree

Master of Arts in Education

University of Northern Iowa

by

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July, 1986
This Research Paper by: Jie-Qi Chen

Entitled: A Selected Cross-Cultural Study of Piaget's Stage Theory of Cognitive Development

has been approved as meeting the research paper requirement for the Degree of Master of Arts in Education.

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ABSTRACT

The large number of research studies which have been published on the cross-cultural implications of Piaget's cognitive development theory are extremely varied. This study attempts to classify them into three areas: sequence of cognitive development, rate of cognitive development, and the influential factors of cognitive development, in order to verify the universality of Piaget's theory and put forward some suggestions about educational practice.

The review and analysis of related literature indicates that first, the universality of the sequence of cognitive development only deals with sensorimotor and preoperation stages rather than concrete and formal operational stages. Second, the age of acquisition of each stage criterion varies in different cultures and environments. Finally, cultural structures, type of schooling, and different environments are all influential factors in cognitive development. They are either interactive or separate in influencing cognitive function. It is these factors that create the different rate of cognitive development as well as non-universality of concrete and formal operational stages. Moreover, it is this point that suggests to us that educational practice should focus on not only the product but also the process of cognitive development.
Chapter 1

THE PURPOSE

Introduction

The most significant theory of cognitive development in this century comes from the work of Jean Piaget (Carlson, 1973). The ideas of Piaget have been applied to practically every aspect of education. These ideas are based on Piaget's theory that every individual progresses through four cognitive developmental stages: the sensorimotor stage, the preoperational stage, the concrete operational stage, and the formal operational stage. According to Piaget, the stages follow an invariant and universal sequence regardless of culture, however, there are variations in the rate of progress through the cognitive stages, and these variations arise from differences in cultural influence and learning experiences.

During the past two decades, a large number of studies concerned with the cross-cultural implications of Piaget's developmental theory have been conducted. First, they are extremely heterogeneous. There are agreements and disagreements concerning the theory. Second, because the research verifying Piaget's stage theory in Asian countries began only in the last ten years, the literature is very limited, and most of studies in the literature focused on comparisons among European, American, and African children.
Rather than compare a few cultures, the better approach of cross-cultural research in cognitive development, is to collect, compare, and analyze the data from different countries. In this way, the universality of the criteria involved can be assumed, and functional equivalence of these criteria as phenomena occurring naturally in various cultures can be found (Berry, 1973).

Statement of the Purpose

The purpose of this study is to collect comparative data from five continents through a literature review and analyze them in order to verify whether the stages and hierarchical ordering hold for children all over the world and to identify the situational components that determine whether a particular cognitive operation will be applied.

The following questions will be answered in this study:

1. Does the cognitive development in various cultures follow the same sequential succession of stages as described by Piaget?

2. If so, do these stages appear at approximately the same age levels?

3. If not, are the differences due to the influences of variant cultures and learning experiences?

Importance of the Purpose

The area of greatest practical significance and applicability of Piaget's developmental theory is education. If the results of
this study indicate that Piaget's criteria are considered absolute or universal and they really reflect and explain children's cognitive development, then there are two main ways in which this theory can be used to guide and improve educational practices.

First, one universal criterion of children's cognitive development has been established. According to that, psychologists and educators can investigate children all over the world, and compare them, in order to determine the different levels of cognitive development from one country to another country. In the meantime, the "natural" environment of the child, in which the cognitive development of the child was delayed or fulfilled ahead of the time, can be found.

Second, several researchers made this point in respect to relationship between the children's level of cognitive development and curricula. It has been demonstrated that level of cognitive function is of critical importance to performance on cognitively based curricula (Field & Cropley, 1969; and Szeminska, 1965). For example, children who are in the pre-operational stage rather than concrete operational should be allowed and encouraged to manipulate materials by hand instead of learning only by reading or listening. In turn, exposure to such a curriculum can affect level of cognitive functioning (Allen, 1968). This is one of the standard by which curricula can be evaluated regardless of cultural differences.
Definition of the Terms

1. **Sequence**—including four hierarchical ordering stages: sensorimotor, preoperation, concrete operation and formal operation.

2. **Sensorimotor stage**—(roughly from birth to 2 years) the infants understand the world in terms of their overt, physical actions on that world. They move from simple reflexes through several steps to an organized set of schemes (Miller, 1982, p.44).

3. **Preoperational stage**—(roughly from age 2 to age 7) no longer does the child simply make perceptual and motor adjustments to objects and events. Child can now use symbols, such as mental images, words, gestures, to represent these objects and events and use these symbols in an increasingly organized and logical fashion (Miller, 1982, p.44).

4. **Concrete operational stage**—(roughly from 7 to 11 years) the children acquire certain logical but concrete structures that allow them to perform various mental operations, such as conversation, classification,--internalized actions that can be reversed (Brainerd, 1976, p.136).

5. **Formal operational stage**—(roughly 11 to 15 years) mental operations are no longer limited to concrete objects; they can be applied to purely verbal or logical statements, to the possible as well as the real, to the future as well as the present (Brainerd, 1976, p.264-265).
6. Piagetian tests--task interviews or a written test designed to measure an individual's stage or level of development as described by Piaget.

7. Conservation--refers to children's understanding that quantitative relationships between pairs of perceptually identical objects remain invariant when the perceptual identity is destroyed.

8. Assimilation--is the process fitting reality into one's current cognitive organization.

9. Accommodation--refers to adjustments in the cognitive organization as a result of the demands of reality.
Chapter 2

REVIEW OF RELATED LITERATURE

The results of various cross-cultural studies of Piaget's cognitive stage theory can be divided into three parts. The first one is the sequence of cognitive development which indicates qualitative changes. The same order described by Piaget has been identified in sensorimotor and preoperational stages. However, the studies of the last two stages indicate that some adults and college students have not reached the formal stage, and some have not even reached the concrete stage.

The second is rate of cognitive development which indicates quantitative changes. Piaget's assumption for the criteria indicates that the rate of development can be classified into at least three groups: the approximate time; earlier or more quickly; and later or more slowly.

The last concern is the factors that influence cognitive development. According to Piaget, cultural and educational differences are the main factors which influence cognitive development. This claim has been supported by many researchers, however, there have also been conflicting findings.
Sequence of Cognitive Development

Piaget's claim: The successive stages that comprise the course of cognitive development regardless of when they may occur, always occur in the same order. Environmental influences can affect the rate of development but not its form. The same order is found in children of all over the world (Brainerd, 1979. p.102).

Sensorimotor Stage

In the study by Uzgiris and Hunt (1967) there were sixty-three items examined with 125 American infants, age arranging from 1 month to 24 months. They found that infants acquire six sensorimotor substages in the same order as those predicted by Piaget. Concerning the test validity, not only did they draw their items from Piaget's original books on sensorimotor intelligence, but most of the sensorimotor behaviors mentioned by Piaget appeared during the test. Concerning the test reliability, the 90% plus interexaminer agreement and 80% test--retest correlation existed. In 1969, Corman and Escalona replicated Uzgiris and Hunt's study with 295 infants ranging in age from 1 month to 26 months. The results supported the earlier study. The invariant order in which object performance and space contents were acquired was the same as the order predicted by Piaget's substages. There were a few minor deviations from Piaget's predictions. However, the measured
contents were acquired in exactly the same order as reported by Piaget.

In a study of American black infants by Golden and Birns (1968), using Piaget's permanence object, they found no social class difference in cognitive performance during the first two years of life. In Asia, Mead and MacGregor (1951) analyzed 4,000 photographs of a longitudinal sample of eight Balinese children (Indonesia), reared in a traditional mountain village. The result seemed to indicate that Balinese infants go through the same general stages of motor behavior as U.S. infants. These studies support the notion that there is a progression of development which is independent from culture.

The data obtained during infancy on the Albert Einstein Scales of Sensorimotor Development (based on Piaget's properties and ordering of the substages of sensorimotor intelligence) also provided similar results. Both Kung San infants who live in the Kalahari desert in northwestern Botswana (Konner, 1977) and Zambia infants from a high-density suburb of Lusaka (Goldberg, 1977) followed same substages described by Piaget.

**Preoperational Stage and Concrete Operational Stage**

Many studies have examined these two stages, however, most of them focused on one concept described by Piaget. The best known example is the succession of conservation.
In P. R. China, there were three major studies dealing with this issue. One investigation of the conservation of the subject was administered to 300 children, ages 4 to 9, by Jing (1982). Another research study dealing with conservation of number, length, space, volume, involved children from thirteen provinces, ages 4 to 11, 20-30 samples of each age (Cooperative group of studying children's cognitive development, 1982) (illustration 1). The third was a test of conservation in space which included 270 subjects in Peking, ages 5 to 13, and 30 samples of each age (Wen-Fu & Fan, 1983). All of the results indicated that no significant differences existed between Chinese children and Piaget's criteria in conservation, and also no significant differences existed among children under similar cultural conditions in different areas of China.

Another study of the preoperational stage was reported by Goldschmid (1973). He studied approximately 250 children--25 boys and girls from each age group of 4-8 years--in each of the following countries: Australia, Holland, England, New Zealand, Poland, and Uganda (illustration 2). The results indicated that the age trends in conservation development for both males and females were fairly consistant from culture to culture.

Attainment of conservation during school ages, typical of European children, was found to be consistent with some African children by two other researchers. Price-Williams' study (1961)

Some researchers believe, however, that it can no longer be assumed that adults of all societies reach the concrete operational stage. For instance, Peluffo (1970) found that conservation was uncertain in Kohoroscimetari and Tukano adults (Amazon), and only 20% of adults can reach the conservation of volume in Sardenia (Italy).

Waddell (1968) and Kelly (1970) also found relatively little conservation in illiterate adults in the Highlands of New Guinea. Additionally, Prince (1968) reported that many trainees of two teacher's colleges in New Guinea did not display conservation of quantity, weight, volume, amount, and length. In adult Australian Aborigines, de Lemos (1969b) found 50% conservation of quantity and 75% conservation of length. Similarly Desen (1970) found only 30-40% conservation of quantity, 10-20% conservation of weight and 0-30% of volume.

Formal Operational Stage

On the basis of limited cross-cultural research studies, it appears that attainment of this stage of cognitive development is not universal, although some researchers reported success on formal-operational tasks with school children. For instance, Philip & Kelly (1974) reported this to exist with sixth-graders in New South Wales, Australia.
Piaget (1972) noted that formal operations emerged during early adolescence — 12 to 15 year of age. Recent research with more diverse populations, such as Dale's study in Australia (1970) and Kincheloe's study in America (1972), however, indicated that formal thought may not be attained until late adolescence, 15 to 20 year of age. Some researchers reported that even many college students had not yet attained all the characteristics of formal thought (Tishner, 1971, in Australia; Lovell, 1961, in British; and Dunbar & Taylor, 1983, in America). Dunbar & Taylor reported 30% of 670 midwestern university students actually tested below the stage of formal operations.

Piaget also considers a 75% success rate as the criterion for the general presence of a particular thought process. Studies of late adolescence in Western cultures, however, indicate that the percentage of subjects succeeding at formal operational tasks ranges typically between 30%-50% (Kohlberg & Gilligan, 1971). Negative results were also reported by Were (1968), who administered tasks of formal operational thinking to 14 to 16 year olds in New Guinea, and by Dasen (1977a), who found this to exist even among schooled 17-year-old Africans, the success rate was well below 50%. Among the unschooled adolescents and illiterate adults the formal operational level could be found with less frequency.
Summary

According to Piaget, stage sequence is a such universal process that it is not affected by the genetic programming and the environmental factors (Flavell, 1971). It is apparent, however, that studies of stage sequence in various cultures obtained questionable results. Agreement with Piaget deals only with sensorimotor and preoperational stages, which might be viewed as "strong" universals. Researchers have been unable to verify that all people can reach concrete and formal operational stages, which might be considered "weak" universals. Furthermore, people who have not reached either concrete or formal operational stages include not only illiterate adults in primitive areas, but also college students in developed countries. In spite of that, no data indicated that the sequence is alterable.

Rate of Cognitive Development

Piaget's claim: "The average age at which children go through each stage can vary considerably from one social environment to another or from one country or even region within a country to another." (Piaget, 1972, p.7)
Assuming that curve p is the age of cognitive development described by Piaget, or obtained with European children, several groups of findings exist.

a. Cognitive abilities develop at the same time with Piaget's assumption in European children.

b. Cognitive abilities develop earlier or more quickly than Piaget's assumption.

c. Cognitive abilities develop later, or more slowly than Piaget's assumption, however, they may eventually reach formal operational thinking.
Several studies reported results corresponding to curve a. For instance, the data on the comparison between black and white infants was obtained in the standardization of the Bayler Scales of Infant Development (based on Piaget's tasks of sensorimotor intelligence, Bayler, 1965, 1969). Included were 1,262 infants, ages 1-30 months, approximately 55% of whom were White, 42% Black, and the remainder Puerto Rican. The sample represented all socioeconomic and educational levels and all geographical regions of the U.S. mainland, but no differences were found between black and white infants on the mental scale. In a study of the reliability of the Bayler Scales of Infant Development it was found that Bayler test had a high degree of tester-observer and test-retest reliability (Werner & Bayler, 1966).

Another comparison was drawn between 83 Indian infants (between 7-12 months of age from a large urban area in India) and 71 U.S. infants of comparable age (Kopp, Kokha, & Signan, 1977). This study indicated greater similarity than differences in sensorimotor functioning of American and Indian infants.

Thirdly, Price-Williams (1961) found no difference between Tiv (a primitive tribe in Central Nigeria) and European children, ages 6-7 to 8-16. All subjects in the sample had acquired the conservations of number and quantity.

There were two other studies with school children. Mermelstein, & Shulman (1967) reported that Teheran children
developed conservation of quantity, weight, and volume in approximately the same time as Europeans. Goodnow & Bethon (1966) found that conservation tasks for weight, volume, and surface emerged at a similar in Europeans in Hong-Kong and Americans.

Curve b.

In Johannesburg, South Africa, Liddicoat (1969) studied 480 healthy urban black infants with 40 infants at each age level from 1 to 12 months. Results indicated that those black babies appeared to be generally one to one-and-a-half months in advance of 210 white infants on all major locomotor measures in the first year of life.

Tuddenham (1969), when applying a battery of 15 concrete operational tasks to European, Black, and Oriental children in California, found that the Oriental children were superior to the Whites on at least half of the items. These results support the finding of superior performance on spatial, perceptual, and numerical tasks by Oriental children reported by Lesser, Fifer and Cladk (1965) from New York, by Salkind (1977) from Japan, and Smith (1968) from Hawaii. They suggested that this may be due to the Oriental children's instruction in an ideographic language, which might aid their test performance, and the emphasis on patience and formality in their socialization.
A typical curve c of "retarded" development has been reported many times. The extent of the time-lag, however, has not always been precisely established in these studies; different reports seem to vary from about one month to three years, and increasing with age.

In the research of infants, Frances-Williams and Yule (1967) studied selected motor skills, such as reaching for a toy under the cover involving eye-hand coordination. They found infants in the United States were between one and two months behind the British babies (1-15 months, 300 samples).

In a study of school age children, Greenfield (1966) and Greenfield & Bruner (1966) found schooled Wolof children (Senegal) all eventually achieved conservation of quantity by age 11-13 years in contrast to ages 9-11 years of Europeans. Another systematic time-lag of 2-3 years on conservation of quantity, weight, and volume was reported among illiterate rural children in Iran (Mohseni, 1966). A lower performance on Piagetian tasks for low socioeconomic class European children was also reported by Peluffo (1962, 1967), Wei (1966), Vernon (1969), and de Lacey (1970a). In the final study, 10% to 20% of low socioeconomic Australian and Europeans had not reached concrete operational thinking (classification) at age 12.

A few studies have been conducted on formal thought. Goodnow (1962) and Peluffo (1967) used tasks of "combinations" and
"permutation" based on those of Piaget and Inhelder (1951).

Goodnow, in Hong-Kong, found that the performance of two groups (low income and semi-or full-Chinese schooling) was much poorer than Europeans in Hong-Kong. Peluffo found that sons of workers, born and living in Geneva, and sons of clerks and professionals, born and living in Sardenia, attained a 50-60 percent success level at age 11, while those living in an underdeveloped agricultural area of Sardenia performed less well (25% at age 11).

Intermediate Curves between a and c.

An interesting example of an apparently intermediate case between curves a and c was reported by Bovet (1968, 1971). When testing conservation of liquid and substance in unschooled Algerian children, she found that the 7-8 year-olds, in contrast to the younger children, seemed to have a solid concept of conservation. However, at 8 to 10 years, there was a "regression", and they did not develop the concept of conservation until 9-11 years-old.

Kohlberg's (1968) results are also difficult to classify. Atayal children, a Malaysian aboriginal group, acquired conservation of quantity usually at 7 to 8 years but partially "lost" it between 11 and 15 years. He concluded:

---the lost did not seem to be a genuine regression but an uncertainty about trusting their own judgement, that is, there was an increase in 'don't know' responses. Apparently, adolescent confrontation with adult magical beliefs led them
to be uncertain of their natural physical beliefs, whether or not they were in direct conflict with the adult ideology.

(p.1029)

Voyat applied a large series of Piagetian tasks to Oglala Sioux in South Dakota (1972). He reported little or no difference in the developmental curves between Sioux and Swiss performance until the age of about 10 years, when the development in Sioux became slower.

Summary

Although there were some research studies indicating that the rate of cognitive development is similar with Piaget's assumption regardless of different cultures, most of studies found that the acquisition age at each stage criterion was different from one culture to another, which was either advanced or retarded. The difference began from the sensorimotor stage. The older the subjects, the greater the differences.

Factors of Influences to Cognitive Development

Piaget made the claim: Four basic factors interact to affect the progressive hierarchization and differentiation involved in cognitive development. They are biological factors, equilibration
factors, general social factors, and education and cultural factors. (Carlson, 1973)

There were only two studies dealing with genetic factors (de Lemos, 1969a, b; Dasen, 1970), and they reported conflicting results. Because of interaction among the four factors it was difficult to examine them separately. More than one of the four factors should therefore be considered at any one time. Thus, cross-cultural Piagetian research has concentrated to date on the assessment of two kinds of influences on cognitive development: culture/environment and education/schooling.

**Cultural and Environmental Influences**

In a study of considerable interest Dasen (1973) examined three groups of subjects: Australian Aborigine with medium contact with European culture, Aborigines with low contact with European culture, and a European group. The report was that (a) Though differential rates of development was found, the stage sequence of Aboriginal development was the same as that found for the Europeans; (b) The rate of development was faster in the medium as opposed to the low contact Aboriginals; and (c) In the low contact group for whom survival requires the use of detailed "cognitive maps", spatial concepts would develop more readily than other Piaget's tasks. This indicated the influences of the ecological and cultural background to the Aboriginals.
This report was largely supported in a later study by Dasen (1975, 1977b), which included 190 children, aged 6-14, from three cultural groups: Canadian Eskimos, Australian Aborigines, and Ebrie Africans from the Ivory Coast. It was found that significant to influential factors caused the rates of development to be less uniform across different areas of concrete operations. Similar results also were reported by Mohseni (1966), Greenfield (1966), Peluffo (1967) and Poole (1968).

Related to the above finding, different conservation tasks seem to be linked to familiarity with the task in real life situations and are influenced by particular day to day activities. For instance, Goodnow (1962) reported that Chinese boys who carry heavy loads of rice conserve weight earlier than children from urban Chinese or Western samples. Price-Williams and Gordon (1969) reported that Mexican children who traditionally make pottery are able to conserve the amount of clay earlier than urban Mexican children.

**Educational and Schooling Influences**

The results of research concerning the effects of formal schooling on the acquisition of Piagetian concepts are divergent. A number of studies (Goodnow & Bethon, 1966; Greenfield, 1966; Mermelstein & Shulman, 1967; and Herson, 1971) have shown a relative lack of impact by schooling on cognitive development. A more definitive study was conducted by Greenfield, using Wolof subjects
from Senegal, French West Africa. There were three groups of children who differed in both level of education and degree of urbanization: (a) bush unschooled children from a rural village who had never attended school, (b) bush schooled children from the same village who attended the local elementary school (French-style education), and (c) city schooled children from Dakar who attended public school there. Greenfield stated that there was no correlation between cognitive level and school attendance among the bush children. Three age levels were studied within each group: first-graders (6-7 year-olds), third-graders (8-9 year-olds), and six-graders (11-13 year-olds).

Other investigators (Dasen, 1977c; Hyde, 1970; Hendrikz, 1966; and Prince, 1968a) dispute this, however, and argue for the importance of schooling as an aid in cognitive development and as one of the principal cultural influences on cognitive development. In Dasen's study, four groups of subjects were examined. All the subjects were from Rwanda and thus from the same cultural setting: one group with normal schooling, two other partially schooled-- one with six years of schooling and one with three years, and the last group with no schooling whatsoever. The result was that the marked deviations existed in the acquisition of the different concepts and formal aspects of thinking when the four groups were compared. The greater the extent of education, the faster in the rate of thought development.
Summary

It is difficult to separate the four interactive factors of Piaget's assumption, and it is not easy to study some of them, therefore, most studies focused on culture and schooling. Different cultures and environments may influence a child's cognitive development through various social requirements, with which the child is familiar makes it easier to resolve the problems. It is apparent that the researchers were unable to develop any definite conclusions relative to the educational and schooling influences. Some researchers found rather high correlations between schooling and cognitive development, while others found little or no correlation.
Chapter 3

CONCLUSIONS

Summary Analysis

It is apparent that the research about cross-cultural cognitive development of Piaget's stage theory is extremely diverse. The reasons were concerned with respect to at least two points. First, as Piaget warned (1968b, p.99), cross-cultural studies are difficult to carry out because they presuppose good psychological training in the techniques of operational testing, namely with free conservation and not standardization in the manner of tests. Most psychologists do not have this training. In addition, each study dealt with a new culture, and very often, a new or changeable task. Second, Buck-Morss (1975) challenged Piaget's theory itself. He pointed out that differences on the cross-cultural study of Piaget's tests may reflect a particular social structure. For instance, differences in cognitive style both reflect and perpetuate the distinction of cultures, societies, and classes. Thus, the results of Piaget's tests differ mainly with the structure of the children's society and their place within it, rather than cognitive structures. Variant social structures result in conflicting research reports.

It is impossible to identify a definite conclusion, but it is possible to explore a common tendency among them. That is, in any
kind of culture, the differences of cognitive development raise with increasing age, and this includes both the sequence and the rate of cognitive development.

With respect to the sequence of cognitive development, sensorimotor and preoperational stages have been identified on almost five continents. However, there is not enough evidence from which to draw definitive conclusions about the universality of the last two stages. The subjects who did not reach those stages were found not only in developing countries, but also in industrialized countries, and they were not only illiterate adults but also college students.

The explanation of this phenomenon may be related to two aspects. First, Piaget's cognitive theory concerns how to integrate knowledge rather than what is to be known, and cognitive structure in thought, especially logical thinking, rather than the level of intelligence. There are more mathematics or physical-science students reaching formal operations than arts or language students. This may be because the former majors pay more attention to how to think than the latter ones (Schwebel, 1975). And there are more high school teachers reaching formal operation than kindergarten teachers though both are college graduates. Success in some careers requires more logical thinking than in others (Taylor, 1985, unfinished research). Logical thinking was found to have almost no relationship to college selection criteria (high school rank and SAT scores). The lower stage of cognitive development is not
necessarily related to lower intelligence or achievement (Schwobel, 1975).

The second consideration is related to the type of schooling. According to Piaget, child development is a process from illogical thinking to logical thinking. Synthesizing a number of research studies, an interesting fact emerges: while children in sensorimotor and preoperational periods have not developed logical thinking and have not attended schools, the research studies about their development appeared same. Conversely, when schooling influences appear in concrete and formal operational periods, children developed logical thinking, and the conflicting research results existed. In an attempt to answer this, Allen (1968) found performance for children exposed to cognitively based science curriculum achieved significantly better on Piagetian measures of logical thinking than the performance of children whose science instruction followed the traditional pattern. Only certain types of school experience therefore make a significant contribution to the development of children's logical thinking capabilities. That is why some students who reach high educational levels still remain at lower cognitive levels, and why research studies of schooling influences have conflicting results.

With respect to the rate of cognitive development, the differences begin with the sensorimotor stage, and the older the subjects are, the greater the differences. Canalized theory offers one explanation. Kopp & McCall (1982) indicated that
cognitive development of children may follow a scoop approach (illustration 3). During early infancy, mental development is highly canalized, as represented by the steep sides of the scoop. The influence of similar genetics of human beings appears greater than environmental factors. Thus most infants follow the same developmental sequences of stages at approximately the same ages. As a child is getting older, the development begins to become progressively less canalized, the sides of the scoop fall off, and age becomes less important than environmental influences. Inhelder and Piaget assert that "the growth of formal thinking remains dependent on social as much as the more than on neurological factors (1958, p.337)." Individual differences reflect the cumulative nature of mental development as well as the fact that individuals partly select their own environments.

In brief, the process of a child's cognitive development is sophisticated as well as physiologically mature. As the child grows older, the sophisticated influences of culture and environment increase, and the individual differences become greater.

Implications for Practice

The area of great practical significance and applicability of Piaget's developmental theory is education. The level of a child's cognitive function determines when and how the child performs with cognitively based curricula (Freyburg, 1966). Knowledge of a
child's level of development can and should be used to help "make the match" (Hunt, 1961) between capability and expectation.

With reference to the match between a child's cognitive level and selection of teaching materials, awareness of how structures grow will provide guidelines for the teachers. For instance, according to Piaget, all the basic concepts of arithmetic-number, addition, subtraction, etc. are supposed to be achieved at the concrete operational stage. Preoperational children presumably will not derive much benefit from arithmetic instruction because they do not yet possess the cognitive structures necessary to assimilate relevant information. Children's ability to learn any cognitive content is always "subject to the general constraints of the current developmental stage" (Piaget, 1970, p.713). Furthermore, the ongoing process of a child's cognitive development determines not only when learning can occur, but also how learning can occur (Piaget 1970, P.714). As the term "preoperational" suggests, this is the stage just before children acquire operation, which is mental in the sense of being "internalized" and "in the mind." Thus manual work and subject observation are the main ways to acquire knowledge. Similarly, the chosen form for teaching elementary children is at the concrete level. For instance, the textbook should, insofar as possible, be simply and attractively illustrated, and the important concepts should be illustrated with several pictures rather than with only words or other abstract symbols. Teachers, whenever it is feasible, should avoid explaining concepts on a purely verbal level.
In brief, the application of Piaget's stage theory in educational practice can be considered from two approaches. One is promoting child development by following the processes of cognitive development; the other is teaching knowledge by fostering cognitive processes and structures.
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Cooperative group of studying children's cognitive development.


Appendix

I. Average Scores in Four Covering and Uncovering Operations from 4 to 11 ages

<table>
<thead>
<tr>
<th>Mean</th>
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II. Investigation of Piaget's Conservation

Task of 4-8 Year Olds in Six Countries
III. The Socop Approach