The development of the conservation of substance and weight in students from Sobral, Brazil.

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THE DEVELOPMENT OF THE CONSERVATION
OF SUBSTANCE AND WEIGHT IN STUDENTS
FROM SOBRAL-BRAZIL

A Dissertation Presented
by
CARMEN Z. ALMADOS

Submitted to the Graduate School of the
University of Massachusetts
in partial fulfillment
of the requirements for the degree of
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May 1987
Education
THE DEVELOPMENT OF THE CONSERVATION
OF SUBSTANCE AND WEIGHT IN STUDENTS
FROM SOBRAL-BRAZIL

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CARMEN Z. ALMANDOS

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Luis Fuentes, Chairperson
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Edwin Driver, Member

Mario Fantini, Dean
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DEDICATION

To my husband, Dr. F. Abel Ponce de Leon for his trust and help which make me able to perform the not always compatible roles of mother, wife and professional.

To my children Pedro Alonso and Marisol who helped me in their own ways.

To my parents who always were very supportive, in spite of being far away.
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ABSTRACT

The development of the conservation of substance and weight in students from Sobral, Brazil.

May 1987

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This study investigated the development of the concept of substance and weight in students from Sobral, Brazil. A total of 209 students from 6 to 13 years of age and currently attending first to seventh grade were interviewed individually. Subjects were drawn from a school, attended by children of middle socio-economic status, located in the urban area of the city. In accordance to a developed questionnaire, subjects were asked to predict, judge and explain their answers for each type of quantity (substance and weight) and for each type of transformation (sausage, disk and seven pieces). A total of twelve answers per experimental subject were scored. A qualitative and quantitative (hierarchical analysis of variance) analysis was carried out. Same stages (non conservation, transitional and conservation), same sequence (substance followed by weight) and same type of explanations (perceptual, general and specific) as predicted by Piaget's theory were found. Students from this study, as a whole, acquired conservation of
substance at eleven years of age, but they did not show acquisition of the concept of weight. However, about half the eight and nine year old children attending third grade demonstrated to have acquired the concept of substance, thus showing the same pattern as described for other western cultures. In the same way ten and eleven year olds attending sixth grade demonstrated acquisition of the concept of weight. Evidence of a highly significant (P < 0.001) grade effect on the attainment of conservation for all type of transformations, is presented. Sex and age effects were not significant. Older children in the same grade did not give significantly more conserving responses than younger ones. Finally, the disk transformation seemed to be able to measure conservation of substance better than the sausage and seven pieces transformations, while the latter two might be more useful for measuring conservation of weight.
TABLE OF CONTENTS

ABSTRACT ................................................................. v

LIST OF TABLES .......................................................... x

Chapter

I. INTRODUCTION ......................................................... 1

Problem of the Study ............................................. 2
Purpose of the Study ............................................. 4
Significance ......................................................... 4
Limitations ......................................................... 5

II. REVIEW OF THE LITERATURE ........................................ 6

Piaget's Developmental Approach ............................. 6
Developmental Stages ............................................ 7
Sensory-Motor Period ........................................... 7
Pre-Operational Period ........................................ 8
Concrete Operations Period ................................. 10
Formal Operations Period .................................. 11
Basic Theoretical Concepts in Piaget's Theory ........ 11
Factors Responsible for the Cognitive Structures .......... 12
Innateness of the Structures in the Nervous System .... 12
Physical Experience ............................................. 12
Social Interaction ............................................... 13
Equilibrium ....................................................... 13
Concept of Conservation ...................................... 14
Methodology of Jean Piaget .................................. 15
Stages in the Process of Acquiring Conservation .......... 16
Non-Conservation Stage ....................................... 16
Intermediate State .............................................. 17
Conservation Stage ............................................. 17
Operations That Make Possible the Acquisition of Conservation ................................. 18
Reversibility ....................................................... 18
Identity ............................................................. 18
Compensation ..................................................... 19
Assessment of Conservation .................................. 19
Criticisms of Piaget's Theory ............................... 21
Principal Areas of Application of Piaget's Theory ........ 23
Education .......................................................... 23
Cognitive Assessment ......................................... 26
Cross-Cultural Studies ........................................ 26
Cognitive Deficiency ........................................... 27
Social Approach ................................................ 28
Culture, Social Interaction, and Experience ............ 31

vii
1. Number of observations in the sample, classified by grade level, age and sex ...................... 46
2. Number of answers by type of explanation and age for first grade children ...................... 54
3. Number of answers by type of explanation and age for second grade children .................. 55
4. Number of answers by type of explanation and age for third grade children .................... 56
5. Number of answers by type of explanation and age for fourth grade children ................... 57
6. Number of answers by type of explanation and age for fifth grade children ..................... 58
7. Number of answers by type of explanation and age for sixth grade children ...................... 60
8. Number of answers by type of explanation and age for seventh grade children .................. 61
9. Percent of conservation responses for substance and weight according to type of transformation and age level ............ 63
10. Number of subjects in non-conservation (NC), transitional (T), and conservation (C), stages for substance and weight according to type of transformation and age level ........... 65
11. Percent of conservation answers for substance and weight by type of transformation and grade level .................. 66
12. Least squares hierarchical analysis of variance of the conservation scores of substance and weight obtained for the sausage transformation .................. 68
13. Least squares means by grade and age within grade of the conservation scores of substance and weight obtained for the sausage transformation ..................... 70
14. Least squares hierarchical analysis of variance of the conservation scores of substance and weight obtained for the disk transformation ..................... 72
15. Least squares means by grade and age within grade of the conservation scores of substance and weight obtained for the disk transformation ............................. 74

16. Least squares hierarchical analysis of variance of the conservation scores of substance and weight obtained for the seven pieces transformation ............................. 76

17. Least squares means by grade and age within grade of the conservation scores of substance and weight obtained for the seven pieces transformation ............................. 77
Conservation is a powerful idea not only in science but also in the conduct of everyday life. We need not pause over its generality in mathematics, in which it plays such a crucial role in the idea of a function, or in physics, in which the conservation theorems are so powerfully an extension of the common sense version. Indeed, much common sense and all of science will be impossible without conservation. (Bruner, 1966, p. 183)

According to Pinard (1981) the main reason to study the concept of conservation is its importance in the child's cognitive development. Without conservation the child will not be able to learn other concepts.

Piaget and his co-workers have been working for almost 50 years, building a theory of cognitive development. To recognize Piaget and his work in the scientific community is to continue his work, even if a contrasting viewpoint is going to be taken.

Flavell (1963) cited several authors that studied the notion of quantity in children (Apostel, Morfs, Mays and Piaget, 1957; Inhelder, 1936; Piaget and Szeminska, 1939; Szeminska, 1935). But it was Jean Piaget who focused his interest in discovering how the child constructs and understands several cognitive concepts during his development.

Piaget's intensive work in the field of conceptual development has opened new horizons and new interests especially for psychologists and educators enabling them to understand and know more about the cognitive behavior of children.
One of the most used concepts in our world is that of property; by this it is meant the properties of objects. Without this concept comprehending the world around us would be more difficult.

When the child becomes aware and understands that certain properties of an object remain the same even though the object changes, then he begins to view his surroundings with a different perspective. Hence, his reasoning becomes more and more like that of an adult.

This chapter will describe the problem, purpose, significance and limitations of this study.

**Problem of the Study**

Piaget, in his early studies carried out in Geneva (1941), found that conservation of mass is first acquired at about seven to eight years of age, followed by conservation of weight at around nine to ten years of age and conservation of volume after twelve years of age. Piaget also reported to have found three stages in the process of acquiring conservation: Non conservation stage, Intermediate stage and Conservation stage. The order of appearance being the same in all individual subjects.

Piaget's findings were generalized and are used as a norm to compare the development of children.

Most frequently, researchers have repeated Piaget's experiment with the purpose to know if his theory can be applied to different societies. Most of the research has been done in Western European countries and the United States of America with similar results.
Studies carried out by Elkind (1961); Lovell and Ogilvie (1960, 1961); Smedslund (1961) and Goldschmid (1967) have generally supported Piaget's observations with regard to the stages and age at which those stages appeared.

In general, cross cultural studies have reflected the point of view of the Western world. The main goal of those studies were to compare different aspects of life in other societies with the objective of knowing more about the influences of the social factors and the universality of the stages. Lately, cross cultural studies have raised several questions about the effect of different variables on the discovery of conservation (Price-Williams et al. 1961; Landerau and Pinard, 1962; Bruner, 1966; Mohseni, 1966; Greenfield, 1966; Kamara and Easley, and Kiminyo, cited by Dasen, 1977).

Based on personal work experiences, this researcher believes that some of Piaget's theoretical points of view do apply to other diverse groups of children and that the sequence of developmental stages, as described by Piaget, appear to be the same. However, there seemed to be differences between societies with regard to the ages at which children reach each of those stages.

To investigate and acquire information from other cultures will increase our understanding of the process of conservation and its universality. This research was conducted in a population of Brazilian children who are located in the city of Sobral, the state of Ceara, in the Northeastern region of Brazil. It is the intent of this study to answer the following questions: Does conservation develop among these children? At what ages do these children acquire the concept of
conservation of substance and weight? Do these developmental processes follow the same stages proposed by Piaget?

A review of cross cultural studies have provided evidence that culture and ecology are directly related with cognitive development (Bruner, 1966; Berry, 1966; Dasen, 1972b, 1974; Goodnow, 1962). However, the findings suggest that there are conflicting results with regard to the ages at which the conservation of substance and weight appear.

**Purpose of the Study**

The object of this study is to contribute to the understanding of the concept of conservation of substance and weight suggested by Piaget and to investigate its validity among Brazilian children residing in Sobral, Ceara, Northeast Brazil.

**Significance**

To date, cross-cultural research has been mainly conducted in Western Europe and the United States of America, few in Africa and in Australia.

This study will provide some evidence of how another group with specific cultural characteristics responds and performs with regard to Piaget's conservation tasks. This work will also provide data which will be used for practical purposes depending on the specific academic goals and philosophy of a given school.
This study will serve as a model and encourage other researchers in Brazil to provide more data within the scope of conservation tasks.

**Limitations of the Study**

The following limitations have been identified:

- Observations were based on a sample obtained at one private school and results should only be generalized to that population.
- Since subjects belong to one socio-economic status, the results could probably be inferred to all children who belong to the same socio-economic group within the city of Sobral.
- Generalizations from this study are neither appropriate to other socioeconomic groups in Sobral, nor to students in other parts of Brazil who can be classified as having the same socioeconomic status as the subjects of this study.
- This study will not measure the teacher's style, nor the curriculum utilized by the school, although these variables might also influence the acquisition of conservation.
CHAPTER II

REVIEW OF THE LITERATURE

Piaget's Developmental Approach

After centuries of research, even now, the study of knowledge remains a problem that makes different scientists adopt different positions in the debate.

Piaget did not believe that ideas are innate nor did he believe that ideas or knowledge are an organism's response to the stimulus that comes from the environment. He believed the organism plays a much more important role. It interacts with the environment. Knowledge is the result of this interaction.

How any adult perceives his environment and the objects inside it, is achieved through his evolution, stage by stage. All the objects have various characteristics. Among them are: number, substance, weight, volume, etc.

Conservation is a key issue in Piaget's work. The author thinks, from the study of Piaget's theory, that conservation is one of the most important concepts the child needs to construct in order to acquire any other concept. Thus, a better understanding of the world and its objects is possible.

In a review of the literature, different scholars have rephrased in different ways the meaning or definition of conservation. They all agree the basic meaning of conservation is the invariability of different properties of the object in spite of apparent changes that can
be performed on it. In order to acquire this concept any child has to go through different cognitive stages, has to perform different mental operations to be able to understand that certain properties of the object continue being the same even though the object has altered its form.

An incredible amount of research has been done and still is being done in this subject. Repeating Piaget's experiments in different parts of the world, using a similar or different approach, as well as the introduction of other variables and other methods to analyze the data.

With the acquisition of this concept, the way the child perceives and understands objects around him changes completely and leads him to acquire more complex concepts. As Pinard (1981) says: "...psychology owes to Piaget the discovery of the role of conservation in cognitive development" (p. ix).

**Developmental Stages**

During psychological development, Piaget found three major periods, divided in stages which are different from each other.

Original structures will appear in each stage giving them the proper characteristics; the child will deal and interact with the environment using different manifestations of intelligence. (Piaget, 1967a, p. 8).

**Sensory-Motor Period**

From birth to the acquisition of language. The child moves, from
an egocentric biological organism to a social one, using mental operations. During this period, as the name indicates, the child relates and interacts with the environment basically as a biological entity in order to satisfy his physical needs. The child will mainly use sensory perceptions and motor skills. For Piaget the first period of development is extremely important. He analyzed six stages and is extremely interesting to witness in the child what Piaget called the "Copernican revolution" (Piaget, 1967a, p. 9). The idea that the child has of the object and about the environment near birth changes completely at the end of this period. The environment has permanent objects independent of him; the child does not have to see the object to know that it exists. He himself is different from other people.

Pre-Operational Period

The appearance of language changes the way the child interacts with his outside world, becoming more and more a social animal who through verbal representations is able to think about his past and future actions.

According to Piaget (1967a),

The acquisition of language has three consequences essential to mental development: (1) the possibility of verbal exchange with other persons, which heralds the onset of the socialization of action; (2) the internalization of words, i.e., the appearance of thought itself, supported by internal language and a system of signs; (3) last and most important, the internalization of action as such which from now on, ... can represent itself intuitively by means of pictures and 'mental experiments' (p. 17).
Pre-Conceptual Stage. From 2 to 4 years old. (Piaget, 1967b, p. 123). During this stage the child cannot deal with the world on a symbolic level, but it is especially during this time that he prepares himself to aim at that goal (symbolic representation), thanks to the biological development and the two mental processes that will be explained later (assimilation and accommodation). The most important characteristics in this stage are: symbolic games and imitation. Through imitation the child has meaning of something or somebody missing.

Perception is what leads the child to interpret the world the way he sees it. Perceptual illusions are very common: a small object would look lighter than a large one of equal weight; there could be more clay in one sausage than in a ball, even though they both contain equal amounts. Berlyne (1957) writes:

The three year old child ... has to use something midway between the concept of an object and that of a class which Piaget calls the 'pre-concept.' On a walk through the woods, for example, he does not know whether the same snail keeps on reappearing. The distinction, in fact, means nothing to him; to him they are all 'snails' ... Unlike adults, who reason either deductively from the general to the particular or inductively from the particular to the general, the child at the pre-conceptual stage reasons transductively from the particular to the particular. It is a form of argument by analogy ...
(Murray, 1974, p. 43).

Intuitive Stage. From 4 to 7-8 years old (Piaget, 1976, p. 123). Although perception dominates his thought, the child does not pay attention to the transformation that happens in the object. He centers his thought on only one characteristic, is not flexible, using Piaget's
word is "irreversible" (Piaget, 1967a, p. 32). He stated:

At every stage during the period from two to seven years one finds all the transitions between two extreme forms of thought, but the second form gradually gains precedence over the first. The first of these forms is thought by means of pure incorporation or assimilation, in which egocentricity excludes all objectivity. The second form is that of thought adapted to others and to reality, which is the preparation for logical thought (Piaget, 1967a, pp. 22-23).

Concrete Operations Period

From 7 to 11 years old (Piaget, 1967b, p. 123).

During this period the child is little by little near to achieve the goal of true socialization, leaving behind his egocentric world. The child is able to perform more and more like an adult; he can organize his thoughts into coherent, total structures even though his actions are strictly reduced to concrete objects, the ones he sees.

The mental operation that characterizes this period is reversibility. Contrary to the other period (2-7), the child's thought is more flexible, able to go mentally from one point to the other and come back to the same point of departure.

It is during this period that the notion of conservation is present. The child finally achieves one of the major tasks of the pre-operational period. Conservation, "refers to the ability to recognize that certain aspects of an object or person remain constant despite changing conditions or transformation" (Pulaski, 1980, p. 51).

The child being able to hold mentally the original image of an object, will no longer make decisions about it, on the basis of what he
perceives. The objects in his surroundings will change and they will be more meaningful to him.

**Formal Operations Period**

From 11 or 12 to adulthood (Piaget, 1967b, p. 123).

In this part of development, the person becomes capable of reasoning beyond concrete objects independent of action. Thought reaches the highest level, reasoning is hypothetic deductive. "Formal operations, therefore, consist essentially of 'implications' (in the narrow sense of the word) and 'contradictions' established between propositions which themselves express classifications, seriations, etc." (Piaget, 1967b, p. 149).

As the adolescent gets older, he is able to work with more characteristics of the object at the same time. His thought is more systematic and all possible combinations are probable.

**Basic Theoretical Concepts in Piaget's Theory**

It is impossible to study Piaget if we do not understand his biological point of view and how he integrates biology into the study of knowledge. Organisms and environment and how they interact are the key issues in Piaget's work.

Piaget's greatest contribution may be his brilliant analysis of how human knowledge slowly develops beyond its biological inherited origins through a process of self-regulation based on feedback from the environment leading to internal reconstruction (Pulaski, 1980, p. 9).
Piaget is not a nativist nor a behaviorist. He is an interactionist. Biology is the basis of his theory, how the person as a biological entity following the steps of evolution interacts with the environment. His main interest is the growth of thought.

Factors Responsible for the Cognitive Structures

All the factors play a very important role, none can explain by itself the construct of dynamic structures.

Innateness of the Structures in the Nervous System: Maturation

Piaget does not believe that cognitive structures are innate, although he does not deny the importance of the neurological factors.

The cognitive structures are not present at the time the child is born, they develop step by step during the child's life as a result of the interaction with the environment. According to Piaget the presence of cognitive structure becomes a necessity.

Physical Experience

The action the subject performs towards the object seems to be a very important variable within Piaget's theory. From this point of view "the operations originate from actions and the actions bear upon the object" (Murray, 1974, p. 52).

To only look at the object and be aware of its properties is not enough to create the logical necessity for cognitive structures.
Social Interaction

Even though Piaget takes into account the social factor, he did not study it extensively. He did not offer enough data about the effect of the environment on the development of conservation. What he assured is that regardless of the social milieu, the order of stages are the same.

Equilibrium

Social interaction, maturation and physical experience interact and equilibrate with each other to form a unity which Piaget called cognitive organization.

It is important now to talk about another theoretical concept, adaptation. Piaget defines it "as an equilibrium between assimilation and accommodation, which amounts to the same as an equilibrium of interaction between subject and object" (Piaget, 1967b, p. 8).

The concept of reversibility is extremely important in understanding equilibrium, "this growing reversibility assures progress toward equilibrium when all the virtual transformations (equivalent here to possible operations) are compensated" (Piaget, 1967b, p. 130).

Adaptation is possible thanks to two inverse actions, present in any intelligent act. Both concepts, Assimilation and Accommodation, have a biological basis too. "Assimilation may be used to describe the action of the organism on surrounding objects, in so far as this action depends on previous behavior involving the same or similar objects" (Piaget, 1967b, p. 7).

Accommodation is the converse action, the environment acts on the organism and the organism in order to respond has to accommodate.
Describing the nature of this process, Flavell (1963) stated:

The essence of accommodation is precisely this process of adapting oneself to the variegated requirements or demands which the world of objects imposes upon one... A receptive and accommodative mouth and digestive system are not really different in principle from a receptive and accommodating cognitive system (p. 48).

**Concept of Conservation**

Although it is possible to isolate conservation and study it alone from the psychological point of view, it is still necessary to take into consideration the developmental stages.

Conservation is a concept that a child acquires step by step. First, the child achieves the object permanency, then he perceives and distinguishes its qualities (colors, shape and material). As the child grows in age, he moves from the qualitative identities toward quantitative constants. Using the concrete and formal operations the child conceptualizes the invariance of quantitative properties such as: substance, weight, volume and number.

During the period of concrete operations, the child has systems of operation that are called groupings: these have five properties. One of the properties is reversibility and it is precisely the reversibility which is responsible for conservation.

With conservation present in the thought of the child, the qualitative properties of the objects will not change as attention is directed to different parts, or if objects are displaced or changed in form.
The conservation concept extends far beyond the few privileged domains to which it is customarily restricted. Without loss to its essential meaning, which is the invariance of physical and logical properties of objects in the face of apparent changes brought about by the actions the subject performs on these objects, conservation is the very heart of all the concepts the child constructs... Conservation is, in fact, the result of the reversible character of mental operations which need to be brought into coordination in order for any concept to be acquired by the child (Pinard, 1981, pp. 4-5).

There are different types of conservation that the child acquires throughout all of his development, but not all of them are acquired at the same time. Different objects (solids or liquids) produce different effects in the child; the less resistant properties will appear first. In this way, substance offers less resistance than weight and weight less than volume.

**Methodology of Jean Piaget**

Using the clinical method, as Piaget used in all his research, he tested for the achievement of the concept of conservation (substance, weight and volume).

Piaget (1941) in his description of his work, stated that children interviews were open talk. Hence, allowing for questioning and interpretation of answers and at the same time leading to more questioning based on previous answers which in turn will allow one to assess the development of conservation in a given subject.

Subjects ranging from 4 to 12 years of age were individually interviewed. Children of different ages were necessary in order to
learn about different stages of development. One of the most famous
tasks developed by Piaget was that of the use of clay balls. Two clay
balls were presented to the child being interviewed who was allowed to
handle the balls and to add or subtract clay as she or he wished to make
them exactly the same.

After the child agreed that they were exactly equal, Piaget rolled
one changing it into a sausage shape and asked the subject whether the
amount of clay in the latter was the same as in the remaining clay ball.
Questions related to weight and volume were also asked. After obtaining
the child's response, Piaget changed the sausage shape clay into a ball
and asked the subject to evaluate the amount of clay in both clay balls.
When the subject agreed that the amount of clay was equal then other
transformations were tested in the same manner as described for the
sausage one. Piaget found that conservation of mass is acquired first,
followed by conservation of weight and later by conservation of volume.

It is very important to know that the cognitive structure the child
acquires and uses for the conservation of substance is transferable in
resolving the problem of conservation of weight and volume, only when
the child reaches the proper developmental age.

**Stages in the Process of Acquiring Conservation**

**Non Conservation Stage**

Before 7 years old, the child does not admit any conservation.
Perception is imposed over the cognitive structure, the child can
perceive the object with qualities, but not as a total entity. He centers his attention on a single attribute, the sausage has more quantity, weighs more because it is longer; he cannot think in longer and thinner at the same time.

**Intermediate Stage**

Following Piaget's thought, the child is in a stage of disequilibrium, doubt is the principal characteristic of this stage, at the same time his thinking is more flexible.

The child does not center his attention on only one attribute of the object but still there is a conflict between thought and perception and there is not a definitive winner. Sometimes the child realizes that longer and thinner are related; therefore, he thinks there is the same amount of clay or both weigh the same. In other instances, there will be a perceptual illusion were the thinking succumbs to perception. Generally, the child will think there is more quantity of clay in the cookie because it is round and flat. "This, then, is a stage in which disequilibrium predominates. The child begins to give the right answers tentatively, based on intuition but not on logical conviction" (Pulaski, 1980, p. 56).

**Conservation Stage**

In this stage, contrary to the other one, operational thinking is imposed over perception. There are no more perceptual illusions, the child no longer allows perception to rule his thoughts. If the clay
gets longer, at the same time it gets thinner; it is the same amount of 
substance and both weigh the same.

During this stage the child can explain that nothing has been or 
taken away. He also can explain that the sausage can be returned to the 
original shape. "He is able to regulate all the factors involved. He 
notices both the length and the width of the sausage, and how one 
compensates for the other... whatever shape it takes, it's still 'the 
same stuff'." (Pulaski, 1980, p. 56). Definitive answers are present. 
Conservation concept has been achieved.

Piaget (1961) indicates that on the average, the conservation of 
the quantity of matter is acquired only at about seven to eight years 
and that of weight around nine to ten years of age.

Operations That Make Possible the Acquisition of Conservation

Reversibility

The child discovers that for any operation there is another, an 
opposite operation which cancels it. He also is able to reverse the 
operation to its starting point; e.g., $4 + 3 = 7$ so $7 - 3 = 4$. If we 
rolled the ball into sausage, we can return it to the original shape.

Identity

The child goes beyond the quality identity. He assures it is the 
same quantity because nothing has been added or taken away. The child 
is able to isolate the qualities; e.g., weight and substance. "Identity
requires that one of the elements of a group be such that combining it with any other element leaves that element unchanged. In addition, the identity element is 0; adding 0 to any number leaves it unchanged" (Pulaski, 1980, p. 57).

Compensation

Because there are no perceptual illusions the child knows and realizes that the characteristics of the object change but they compensate each other. Using compensation the child is able to know that an object gains in width what it loses in height. The cookie is flat but is wider; the sausage is longer but is thinner.

Assessment of Conservation

Elkind (1961) replicated several of Piaget's conservation studies assessing the children's discovery of the conservation of mass, weight and volume by means of the "ball clay" task. He interviewed and evaluated one hundred seventy-five subjects. Children from 5-11 years of age from kindergarten to sixth grade were questioned individually.

Elkind found in accordance to Piaget's findings that: "the conservation of mass did not usually appear before the ages 7-8; the conservation of weight did not usually appear before the ages 9-10; and the conservation of volume did not in most cases appear before the age of 11" (Sigel & Hooper, 1968, p. 17).

Bat-haee (1971) using the "ball clay" task reported that his results "support Piaget's assumption that from 8 yr. of age onward the
child is able to break away from the influence of perception and is increasingly able to use logical thought" (Bat-hae, 1971, pp. 167).

Studies carried out by Lawson (Renner, 1976); Renner, 1976, have demonstrated that Piaget's tasks normally measure what they are supposed to measure.

The studies carried out by Goldschmid, (1967, 1968); Goldschmid and Bentler, (1968); Goldschmid et al., (1973) are of special interest because they all have demonstrated the psychometric characteristics of the Piagetian tasks. Data is still being accumulated on the validity of Piaget's tasks. Goldschmid and Bentler (1978) constructed a conservation scale based on conservation items, they have demonstrated that the conservation scale is an instrument which shows reliability, internal consistency, homogeneity and validity when used with children in the United States. Further, Goldschmid et al. (1973) in applying the Concept Assessment Kit Conservation Test to six different cultural groups revealed that the test shows internal consistency. The conservation scores tend to be a reliable measure and there was a general correspondence in age trends. Hence, the researchers were able to conclude the following: "...the Concept Assessment Kit seems to be a reliable indicator of conservation across several cultural groups" (Goldschmid, et al., 1973, p. 87).

The psychometric characteristics of the Piagetian tasks still are an issue of controversy. Nevertheless, we cannot deny their value as a reliable instrument to evaluate conservation.
Criticisms of Piaget's Theory

Since their earliest findings, Piaget and co-workers have been modifying their methodological approaches to meet scientific requirements. Different theoretical positions that ranged from similar to contrary have been adapted by different researchers.

Learning theorists, tried to explain the transition from one stage to the other based on social reinforcements. Smedslund (1961) did several studies on the issue of conservation using learning concepts. He designed one specific experiment in order to find out the effects of direct external reinforcement. The experiment included 3 groups of subjects between 5 and 7 years of age. One of the groups (A) was studied with special empirical variables, trying to prove in favor of the learning theory that the particular group treated with special conditions (direct reinforcements) will learn more and faster than the other groups. Smedslund's results did not support Piaget's findings, but he presented doubts about his own results as well. Smedslund pointed out that maybe the responses were a pseudoconcept and not real conservation. "The genuine concept of conservation is inaccessible to experimental extinction, whereas the outcome of simple response learning would presumably be easy to extinguish" (Murray, 1974, pp. 172-173).

Mehler and Bever (1967) reported in their study of children aged 2 years 4 months to 2 years 7 months that they have conservation of number. "These findings were interpreted to mean that non-conservation of quantity was a temporary phase reflecting an over dependence on a perceptual strategy... but the perceptual strategy could be overcome
with sufficient motivation" (Murray, 1974, p. 163).

Braine and Shanks (1965) contrary to Mehler and Bever (1967), found in favor of Piaget's assumption that when young children do not show conservation of number, positional preferences will influence their responses.

Bruner disagreed in several issues with Piaget's theory. He and his group of researchers, besides questioning some theoretical issues tried to intensely study the role of culture. They wanted to change the illusion that some groups, especially from Europe (Geneva) or the United States are considered "normal" and that the rest of the world is trailing behind them. Bruner et al., (1966, p.67) stated... "'there is no standard child,' and 'natural childhood' is hard to imagine outside a cultural context". For Bruner, the linguistic aspect is also a very important variable.

Greenfield (1966) affirms that she and the Cambridge School have disagreed with Piaget's affirmation that cognitive maturation is mainly biologically determined. They emphasized more the role of culture and how different cultures affect individuals. Greenfield was interested in finding different cognitive functioning and studied the effects of instruction.

Probably earliness or lateness of appearance of conservation in different cultures might be related to level of technological development rather than genetically determined.

In essence, one would expect that conservation stages will appear at an earlier age in technological advanced societies. A positive
correlation between technological development and earliness in the age of acquisition of conservation, should be expected up to a certain age when biological developmental limitations would counteract the trend. This is to say that if technological development increases with time within a particular culture then the age at which conservation is acquired will vary between generations by reducing the number of years of age needed to first acquire the notion. Basically, this researcher suggests that the acquisition of conservation is largely controlled by environmental and cultural factors.

It seems that in countries other than the United States of America and Western Europe, a delay in the age at which conservation appears tends to be the rule. This delay being influenced, most probably, by ecological environment and culture. Hence, the importance of knowing the age timing at which conservation appears is granted.

**Principal Areas of application of Piaget's Theory**

Education and psychological assessment are certainly areas of application.

**Education**

If we believe and accept the developmental stages that Piaget describes and their particular characteristics, schools would start taking new directions. The main purpose of the educational process will then be to create a proper atmosphere, so as to stimulate the child's mind for cognitive growth.
Another goal would be to avoid all failure in school, an uncommon situation now-a-days. Instead of punishing the learner by making him memorize concepts that he or she does not understand at that particular time or stage of life, a new curriculum would be implemented to meet the learner's cognitive needs.

Flavell (1963) formulated very important questions that still need to be answered.

Do Piaget's findings imply, for example, that initial teaching of the scientific method and content should be pegged around early adolescence, when the formal operations which make possible genuine scientific thought are said to be developed? What about the age of placement of such traditional subjects as geometry?... Geometry and related topics might be taught earlier than they usually are (p. 365).

There is movement in Europe and the United States, gaining support among educators and school psychologists, to implement new curriculums based on Piaget's findings [Renner et al, 1976; Stafford, 1973a, 1973b; Furth and Wechs, 1975; and Kamii (Parker, 1972); Kamii & Derman (Green et al., 1971)].

Phillips (1975) indicates three important teaching principles that have been derived from Piaget's theory.


   The person's mind is not a passive organism, therefore the learning process must be an active one. Any kind of knowledge is going to be acquired only if the person engaged in the learning process is mentally or physically active.
Different experiences will be appropriate for different ages. Teachers must allow and guide students to experiment with objects or formal relationships. Phillips (1975) writes:

"teaching" is far more than "telling" and even telling—if it is to result in knowledge—must engage the listener as an active participant in the communicative process. In general, the teacher should encourage curiosity and the making of autonomous choices, for therein lie the foundations of cognitive structures (p. 142).

2. Transfer as Sequential Integration of Structures (Phillips, 1975, p. 142).

Until the child reaches the formal operation stage, he will not think as an adult. Therefore, the way he sees objects and his surroundings will be considered wrong according to the teacher's point of view.

The teacher's role should be to accept the different cognitive structures that the child uses at different ages and to integrate these structures in order to help the student to achieve a higher level of cognition, when it is time for him to do it. The development of any child "will be enhanced if his teachers recognize his right to be wrong, for early structures are the foundations of later ones" (Phillips, 1975, p. 143).


Appropriate cognitive conflict will motivate students to acquire knowledge. To use this task in the classroom as a way of learning is not an easy task for the teacher. "The
teacher's role is rather that of a guide—a guide not of a planned tour but of a genuine exploration. So far as possible, he is a consultant rather than an authority" (Phillips, 1975, p. 145).

Cognitive Assessment

As school psychologist, this investigator feels that new approaches to cognitive assessments need to be considered outside traditional approaches. Piaget's theory can be one answer.

Flavell (1963) mentioned a standardization project done by Vinh-Bang and Inhelder at the University of Geneva in 1957 and 1959. Modern psychologists such as: Laurendau and Pinard (1964) from the University of Montreal are working on the standardization of a complete test battery based on Piaget's theory. Based on these works Phillip's (1975) talks about certain characteristics of this new kind of intelligence test. He found the following: 1) They are less structured; 2) A qualitative analysis of the child's performance is extremely important; 3) The tests' items are based on Piaget's theory.

In summary, Piaget's model may be taken into consideration to implement changes in the educational system.

Cross-Cultural Studies

A review of the literature on cross-cultural studies has been done in order to better understand how social factors affect the development of the conservation concept in the child.
For Piaget, the individual is always socialized to some extent. But not all types of social relationships lead to the development of logical thought. The social factor influences through language, intellectual values and rules imposed on thought.

Logical rules are not imposed by the social group like rules of grammar, such as the agreement of the verb with its subject, i.e., by the simple authority of usage and common consent. The form of collective interaction which intervenes in the constitution of the logical structures is essentially the coordination of interpersonal action through common work and verbal exchanges (Piaget, 1967a, p. 129).

The most consistent and frequently noted finding in the literature about cognitive assessment, is that lower socio-economic classes generally performed less well than middle class children in the United States. This may also apply to other countries.

A sociocultural position contrary to the genetic position claims that social class and ethnic group differences in behavior are the product of different experiential factors.

**Cognitive Deficiency**

Hunt (1964), holds the position that not enough stimulation, is the main factor responsible for cognitive deficiency in children of low socio-economic backgrounds.

Much of the research in cross-cultural studies has been undertaken with the affirmation that the behavior of white middle class children is the norm and therefore the cognitive behavior of all the other children should be compared with it. Consequently, when children of low socio-
economic classes or minority groups do not behave like the "norm", they are considered inferior.

This insistence on the part of the researchers that there be a "norm", a specific age when a child should reach a certain goal, must now be questioned by the scientific community. We must begin to explore how different societies deal with the environment and how that affects the cognitive development and the behavior of children.

People are different and each society expects different behavior and different ways to deal with the environment.

This researcher agrees with the following opinion that seems to be appropriate at this time.

That any analysis of human variation must result in the conclusion that variation should be welcomed rather than deplored. At the cultural level, many millennia of evolutionary selection make clear the survival value of human diversity. At the social level, employing a much more limited time frame one can readily see how human diversity contributes to the richness of the social fabric. What is needed are the means to understand and share the contributions each social group can make to human life (Yando, 1979, p. 2).

Social Approach

Because cultures are different from each other there is reason to believe that different performance from children of other cultures that do not match the "middle class children norm" is probably due in part to the test makers' failure to create appropriate tests instead of being signs of deficiencies on the part of the group that is being tested.
Any cross-cultural research that makes conclusions about one particular group must consider the social and cultural factors which are specific to the society under study.

Each individual is indeed a function of multiple variables and all of them must be taken into consideration. Some researchers will consider one factor more than others, but if the other factors are ignored, that particular position becomes biased.

It is regrettable that even now researchers in several study fields have made assumptions and have taken positions damaging to other cultural groups. The main reasons appear to be ignorance and lack of understanding of how diverse groups behave.

With regard to the social factor, Piaget mentioned two different aspects: 1) Factors of Interpersonal Interactions. "These operate by themselves, independently of educational transmissions. In any environment, individuals ask questions, exchange information, work together, argue, object, etc." (Inhelder & Chipman, 1976, p. 262). These interpersonal interactions are present at all times throughout the developmental stages. 2) Factors of Educational and Cultural Transmission. They play a very important role: traditional and educational transmissions, each of them different from one culture to another.

Most frequently, researchers have repeated Piaget's experiments trying to determine if his theory can be applied to different societies. Most of this research has been done in Western European countries and in the United States with similar results. Elkind (1961); Lovell and
Ogilvie (1961); and Smeslund (1961) studied acquisition of conservation of substance and weight with children. Their experiments, among others, support the three stages proposed by Piaget and the age at which the stages appeared.

Lately, interest in doing cross-cultural studies has increased, reflecting always the point of view of the western world. The main goal was to compare different aspects of life in other societies, with the objective to know more about the influence of the social factor.

How universal is Piaget's theory or what part of Piaget's theory is universal? He himself knew that more research was necessary.

Why does the age of each period of development in children change from culture to culture? "It has grown out of an initial conviction about the shaping of influences of a culture on thought. That cultures provide amplifiers in the form of technologies to empower human cognitive capacities" (Bruner et al., 1966, p. xii).

It is this researcher's contention that each culture influences human capacities in different, unique ways, so that each particular individual, regardless of his approach, represents his world according to what his culture emphasizes or demands from him.

The differences between agricultural, semi-industrial or industrial societies are well known. The anthropological literature offers many descriptions of how the environment everywhere affects people. The same is true for a culture within which differences among groups of individuals could be observed. Cognitive styles reflect the demands each particular sub-group makes on its members.
Culture, Social Interaction and Experience

According to Bruner (1966), the differences that have been found among societies are not simply dismissed as evidence that one group has achieved the conservation stage and the other has not.

What seems to vary from culture to culture is not the ability correctly...to shape clods of clay to appropriate equalities. Rather, it is the translation of the primitive idea of a substance into a visual form of both...Unschooled Wolof children do not grow up to achieve "verbal" conservation. Even in their teens they will still tell you that there is more to drink in the taller, thinner jars. But pragmatically, they are quite adequate in handling liquids in the life around them (Bruner et al., 1966, p. 325).

Murray (1972) studied the acquisition of conservation through social interaction. His data indicates that social conflict is a factor that needs to be taken into consideration. His subjects performed at higher stages giving appropriate conservation answers after the experiment.

Price-Williams et al. (1961, 1969) studied the role of experiences and previous manipulation of the specific material involved in the conservation task. They found that there is a positive correlation and indeed the role skills play is a very important factor in the attainment of conservation.

Goodnow (Elkind & Flavell, 1969) criticized the methodology in cross-cultural studies. First, she pointed out the fact of transposing tasks for different milieus and comparing answers that may not be strictly comparable. Second, she mentioned the importance of task
procedures, the way the stimulus situation is structured and how it influences the children's answers in different societies. Her third concern is the use of action in the child's responses. "By allowing for both response forms we may be better able to tell whether a poor performance is the result of a difficulty with the logical demands of the task or with the particular method imposed" (p. 451).

Goodnow believes that the child's skills and his background play an important role in cognitive development. She proposes not to work with variables such as: "schooling—no schooling" or "urban schools—rural schools" and instead "work from skills that unite and divide various milieus" (Elkind & Flavell, 1969, p. 456).

School Versus Non School

Mohseni (1966) studied children aged 5 to 10 years old (schooled and young illiterates) from Tehran. The three main results obtained from the study are as follows: first, the stages of the succession of conservation matter, weight and volume were found in all children; second, there was a delay of two to three years between city and country children; third, there was a non significant difference between Tehran and European children.

Piaget (Inhelder & Chipman, 1976) writes, "Mohseni noticed the astounding lack of activity of the young children who do not go to school and who have no toys, except stones or sticks and who show a constant passivity and apathy" (p. 265). For Mohseni this factor explains his second finding.
Kiminyo (Dasen, 1977) working with Kamba children reported that the three conservation stages were present in this population. No significant differences among sex were found and confirmed Piaget's findings with regard to age. Subjects conserved first the quantity of substance, then weight and finally volume.

Kamara and Easley (Dasen, 1977), reported that the children from Geneva are one year behind in conservation of substance. Conservation of weight and volume appear a year later in Themme children. There were significant differences among unschooled and school children; unschooled children suggest a one year delay.

Laurendeau and Pinard (Pulaski, 1980), found the same succession of stages among French-speaking children. They repeated the experiment in Martinique with children attending primary school with a French curriculum. They found a delay of about four years in the performance of the main operational tasks.

Piaget, referring to the Martinique study says: "an ordinary schooling, with a French curriculum that facilitates comparison, is not sufficient to ensure a normal development of operational structures" (Inhelder & Chipman, 1976, p. 266). Greenfield (1966), studying children from Senegal with the purpose to assess conservation of quantity in rural (unschooled—school children from Busch) and urban setting (school children from Dakar), found the following: 1) There is a correlation between school and intellectual development. By the eleventh or twelfth year almost all the school children have achieved conservation. Only unschooled children have not done so. 2) The oldest
unschooled Busch children (eleven to thirteen years old) showed no significant increase in conservation over the eight and nine year olds.

3) The Wolof children were behind compared to the Western children in terms of chronological age. 4) There was a correlation in terms of grade level and conservation, like in Western groups. 5) A wider gap was found between unschooled and schooled Wolof children from the same rural village than between rural and urban school children.

Greenfield focuses her studies in the qualitative analysis of different types of thoughts, people use different approaches to resolve the same problem. "...it is well to bear in mind that intellectually too there is more than one way to skin a cat - regardless of whether all ways are equally effective for skinning twenty cats, or for that matter, dogs" (Bruner et al., 1966, p. 256).

**Linguistic Approach**

Piaget (Inhelder and Chipman, 1976) mentioned that Sinclair's studies in the linguistic development of the child, and in the role of language in conservation. Most of the common words used on the conservation tasks, such as "still", "more", "less", "the same", are expressed in different ways in the diverse languages. A lack of knowledge of the native language or the impossibility to translate into English or another language will lead the investigator to wrong conclusions. "In Turkish, for example, there is only one vector, which corresponds to our word "still"; to say "more", one says "still much" and to say "less", "still little" (Inhelder & Chipman, 1976, p. 267).
Summary of Major Finding in Conservation Studies

— Cross cultural data suggest that children from Northern Europe and the United States develop earlier the concepts of substance and weight.

— Most of the findings suggest that there is a universal sequence of the stages proposed by Piaget.

— There is a correlation between age and conservation tasks. But there is no agreement about the age when individuals acquire the concept of conservation.

— Findings reviewed from cross-cultural data revealed the importance of the cultural environment in cognitive development.

— Finally, knowing the importance and the multiplicity of variables that are related to the acquisition of the concept of conservation, it seems that further applied research is still needed.
CHAPTER III

DESIGN AND PROCEDURES

Introduction

In this study, the author will evaluate Piaget's theory of conservation as it applies to a Brazilian population of children who are geographically located in the city of Sobral, State of Ceara, Northeast Brazil.

This initial work will focus mainly on the study of conservation of substance and weight in children of different sex, age, and school grade.

Hypothesis

A. The population of children under evaluation will follow the developmental stages to attain conservation as proposed by Piaget.
B. There will be a correlation between the age level and the acquisition of conservation (substance and weight).
C. Older children in the same grade will give significantly more conserving responses than younger ones.

Geographical Location

The city of Sobral is located at about 3° south of the Equator.
This area is characterized by high temperatures with an average maximum of 35° C and an average minimum of 22° C throughout the year with very little variations. Average rainfall is about 800 mm in a normal year and as little as 400 mm in a drought year. Rainfall occurs during the months of January through June followed, on the average, by six months of a dry period. The climatological condition described would classify the area as semi-arid. Cyclical drought periods occur every 13 to 26 years, during which time the area turns to be extremely arid.

Sobral is the second largest city of the state of Ceara. Population size is about 100,000 people. It could be considered a rural city. Its economy is primarily based on agriculture, followed by commerce and services and by the emergence of some industry.

Description of the Sample

In order to control for socio-economic status which may otherwise bias the results, it was decided to choose one private school as the major setting for this study. The chosen school is the oldest, co-educational and of middle to high socio-economic status among other schools located in Sobral. The choice of such a setting also guaranteed to some degree that students would not have a history of undernourishment or other related factors.

Equal numbers of male and female subjects as well as an equal number of individuals per age group were difficult to obtain since total numbers of subjects vary with age, grade and sex.

Two hundred nine subjects participated in this study. Children
from 6 to 13 years of age and currently attending school (1st to 7th Grades), were chosen.

Most of the children in the sample have parents who are medium to large farm owners, business and/or professionals.

Children's I.Q. scores were difficult to obtain since intelligence test norms for that population are not available. Teachers' judgements with regard to their intellectual performances replaced I.Q. scores.

Students Socio-Cultural Environment.

There is a perusal of literature showing and emphasizing the importance of the environmental variables in cognitive development. Thus recognizing that environmental variables play an important role in the attainment of conservation concepts, I will describe, according to my experience and observation, the environment to which the subjects of this study were exposed. In describing some aspects of the cultural patterns of the society of the city of Sobral, this author does not want to be neither ethnocentric nor derogative. My intent is to be descriptive.

Home environment and child rearing.

Home environment and child rearing practices can not be ignored, because they are important cultural variables that influence children's development. Subjects chosen for this study belong to the middle class socio-economic status. Almost all of these students lived in big houses with all the basic commodities of an industrialized society. At least
one maid and a gardener were employed and formed part of the home environment. The care provider (maid) who is always a female, lives in the house. She can resign or be asked to leave the position at any time and be replaced in a short period of time. It is a very common practice that the care provider will take care of the child during the most important years of his/her life. Hence, the relationship between the maid and the children can be described as very important. The maid, due to her lack of education, does not seem to offer much stimulation for the children's intellectual growth.

Mother looks after the house and is responsible to keep it running. Most often mother does not work full time or does not have a pay job at all, but due to other home-related activities and a very active social life, she spends several hours outside the home. Parents showed interest in their children. They relate and participate together in different activities (social and recreational) but specific cognitive interaction does not appear to be a common pattern of behavior.

Kirk (1970) showed in her study a significant correlation between maternal practices and conservation task, especially high was the correlation with conservation of substance. The Sobral family is a very close unit and family ties are extremely important. There is no doubt in my mind that some aspects from the cultural and social environment in Sobral have a positive impact in the children in other areas of development and indeed those variables help them to succeed in their environment.

Observation and informal conversation with parents revealed that
Sobral children have good social skills in the broad meaning of the word. Formal and informal education nurture and challenge the students in a positive way in other areas that were not the purpose of this study to analyse. It seems appropriate to quote what Berry (1966, p. 228) wrote: "...In some sense, then, cultural and psychological development are congruent. Culture characteristics allow people to develop and maintain those skills which they have to".

The tutor or "repetidora".

During the elementary years of schooling, it is a very common practice that a "repetidora", a high school or graduate high school female, will go at least twice a week to the child's house and will help him/her with the assignments. The tutor's main responsibility is to make sure the child does the homework. If parents, usually the mother, are not supervising, then the tutor will sometimes end up doing the homework for the student. When a tutor is not present, mother will assume the responsibility.

Homework is extremely important, is mandatory and almost compulsory. In order for the student to perform well in school, the child needs to invest at least one daily hour, if not more, working after school activities. Parents are very concerned about their children's education and will provide the necessary back up for them to succeed in school. Parents will provide all the materials, hire and pay the tutor and participate in school activities.
Schooling.

In Sobral and in most of Brazil, school hours are from 7:00 to 11:30 a.m. or from 1:00 to 4:30 p.m. with 15 minutes brake as an average. All students from the middle and upper socio-economic class attend school. Absenteeism does not appear to be a problem.

Schooling is very formal, teachers and students have to follow an strict curriculum. Memory plays a very important role and children have very little opportunity to do manipulative activities or do experiments and be inventive, e.g. in the school considered for this study a science laboratory was never used (Principal's personal communication).

The qualitative difference between public and private schools is well demarked. Reforms are taking place in Brazil's educational system, but it seems it will take some time before they are fully implemented.

Criteria for Exclusion

The following factors were considered when selecting subjects for the sample:

1) Special needs children. Children with learning disabilities, brain injury, or emotional problems did not participate.

2) Repeaters. Students who were repeating a grade or who repeated any grade in previous years did not participate. The reason being, that in Sobral, as well as in most of Brazil, social promotion of students is not practiced in the educational system. Therefore, repeaters are considered students who are not performing academically according to their grade levels.
3) Socio-economic status. Students who did not belonged to same socio-economic status were not included in the sample. These students were involved in a special scholarship program that provided tuition free education. The scholarships were not awarded on the basis of academic achievement, rather on the basis of economic need.

4) Discomfort. If a child gave signs of discomfort or expressed discomfort or did not want to answer questions then he/she were withdrawn from the process.

5) Difficulty in understanding. Any child who did not understand the questioning, the purpose of the tasks and/or what is expected from him/her, was not interviewed. It is possible that, since one of the interviewers was not native Portuguese speaker, some children may have experienced difficulty in understanding the questions.

Research Instrument

Based on Piaget & Inhelder (1941) and Elkind (1961) previous studies a questionnaire to assess conservation of substance and weight, was developed.

The questionnaire included a section to obtain information on the subjects' background and also provided opportunity for material identification and agreement of equality. The main component of the questionnaire was divided into three parts by type of transformation (sausage, disk and seven pieces). Prediction judgement and explanation questions were used for each type of quantity (substance and weight) within type of transformation (Appendix A).
Procedures

Following the appropriate ethical procedures, all parents, the principal and teachers were informed about the research by letter and were asked for their support and authorization.

Children were interviewed individually in the school for 30 to 45 minutes. Interviews were conducted during school hours in a room separate from the regular classroom. Participation was voluntary.

Based on Piaget's (1941) and Elkind's (1961) studies, the interviews followed a consistent pattern. Being as flexible as possible, the examiner (E) tried to get as much information as she could from the subjects (S).

In the experiment attempts were made to avoid verbal confusion by clarifying the meanings of the words used and by allowing and encouraging the manipulation of the objects presented to S.

Pilot Study

A pilot study was carried out with a sample of 30 students (first graders). Participating students reacted positively and there were no major problems regarding the question format. However, some changes, like the use of common words, (e.g. "disk" was used instead of "pancake") were made for the final instrument. This pilot study was conducted in Portuguese. An elementary education teacher with native language skills was trained to work with the Examiner (E). This teacher participated, as an observer, during the conduct of the pilot study as part of her training.
Material

Four clay balls of different colors but of the same size and amount of clay were presented to S. Students, in general, were familiar with this type of material.

The Experimental Situation

The subject (S) and the examiner (E) sat down at the table in front of each other. E introduced the experiment briefly and as clearly as possible. E asked S his/her name and some basic information. E handed to S a piece of paper and asked S to draw a person, the main reason for this activity was to give confidence to S and establish some rapport with him/her.

E presented to S four clay balls, equal in size, shape and weight. S was asked to choose two clay balls. After S agreed about the equality of the balls, E asked the predictive questions for the "sausage" shape, for each type of quantity (substance and weight). After S's prediction, E asked S to actually make one of the balls into a "sausage" shape. If S did not want to do it, E performed the transformation and continue with the judgement and explanation questions. Same procedure was used for the "disk" and "seven pieces" transformations. In order to control for the order effect, E counterbalance the order of presentation of the question about the ball and the transformed object.
Data Analysis

Qualitative Analysis

A total of 209 subjects were interviewed. Table 1 shows their distribution according to grade level, age and sex. A qualitative analysis of the answers given by the subjects was carried out. Answers were classified according to Elkind's categorization, as follows:

Non Conservation answers: "(a) Romancing (Piaget, 1951, Introd.), it's more because 'My uncle said so'; (b) Perceptual, 'It's more because it's longer, thinner, thicker, wider, etc "'. The conservation answers were: "(c) Specific, 'you didn't add any or take away,' 'you can roll it back into a ball and it will be the same,' and 'The hot dog is longer but thinner so the same'; (d) General, 'it's the same because no matter what shape you make it into it won't change the amount'" (Sigel and Hooper, 1968, p. 16).

Quantitative Analysis

As it has been indicated in the Research Instrument section, the questionnaire developed for this study was used to assess the conservation of substance and weight in children. Three types of transformations (sausage, disk and seven pieces) were used to evaluate both tasks. Three questions (prediction, judgement and explanation) were evaluated per each task. Thus, a total of six responses per type of transformation and a total of 18 responses per subject were obtained. Responses were scored zero or one depending on the lack or existence of
TABLE 1. Number of observations in the sample, classified by grade level, age and sex

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<td>Sixth</td>
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<tr>
<td>Seventh</td>
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<td>TOTAL</td>
<td></td>
<td>55</td>
<td>154</td>
<td>209</td>
</tr>
</tbody>
</table>
conservation, respectively. Hence the maximum total score per quantity within type of transformation, that every interviewed subject could attain was three.

The statistical unit of analysis was the total score obtained by a subject on each task within each type of transformation. Hence, six dependent variables were analysed, being those of conservation of substance and weight per each type of transformation. For each analysis the fixed effects of grade level, age and sex were evaluated in a three way analysis of variance with no interactions included. The aim of this analysis was to determine the degree of significance of the variables being studied. In all cases it was found that the sex effect did not influence the attainment of conservation of substance and weight for the types of transformations used in this study. A further simple correlation analysis indicated that the sex effect did not correlate with the dependent variables indicated above.

A hierarchical analysis of variance not including the sex effect was finally used to assess the fixed effects of grade level and age on the dependent variables of substance and weight for each type of transformation. The model used was as follows:

\[ Y_{ijk} = u + G_i + A_{ij} + E_{ijk} \]

Where;

\[ Y_{ijk} = \text{value of the dependent variable of the } k\text{th subject of the } j\text{th age who is attending the } i\text{th grade.} \]
Using Piaget's conservation tasks, this work has focused mainly on the study of conservation of substance and weight in children of different sex, age and school grade. The qualitative and quantitative analytical approach let this researchers to assess the effect of the variables stated earlier and the overall performance of children in this sample, as it will be indicated in the next chapter.
CHAPTER IV

RESULTS

Stages in the Attainment of Conservation

Students' answers were classified as belonging to three different developmental stages in accordance to Piaget's theory.

Non Conservation Stage. Children perceived only one aspect of the transformation and did not think about the previous equality of the clay balls. Proportionality among properties did not exist, e.g. long and thin did not have any relationship. Even though answers were incorrect, children would judge them otherwise and be convinced of having a good answer. Doubt did not accompany their answers. Hence, misjudgement about reality was one of the principal characteristics of this stage. The following are examples that illustrate typical answers for this stage given by three subjects of our sample:

Subject: Ana Cristina Age: 7-11 Grade: 1st.
(answer) "There is more quantity on the ball because is all together and the sausage is separated.... I am sure, because I am seeing it".

Subject: Daniel Age: 6-9 Grade: 2nd.
(answer) "There is more amount in the disk, because it is bigger.... I am sure because it is heavier".

Subject: Rose Anne Age: 9-7 Grade: 3rd.
(answer) "The ball weighs more than the seven pieces, because the ball
is heavier and the pieces do not have as much weight. I am sure because the ball is thick and the pieces are big and small".

Transitional Stage. It was clear, in this stage, to observe lack of equilibrium. The students faced a cognitive dilemma. They switched back and forth from conservation to non conservation. The child sometimes paid attention to all the important data from the task and at other times he/she did not do so. Therefore, the amount of clay and the weight were the same at one time and different later on, or vice versa. Typical answers that characterize the transitional stage is indicated by the following examples:

Subject: Andre Gustavo Age: 6 - 10 Grade: 1st.
(answer) "The disk will have more amount, because it is bigger".
(answer) "Both have the same amount, because I only squeezed the ball like this...(demonstration)... I am sure because I only squeezed it".

Subject: Yolanda Age: 8 - 5 Grade: 2nd.
(answer) "The ball will have more amount of clay because it will be round and the sausage will be long".
(answer) "The ball and the sausage have the same amount, because they have the same size. I am sure".
(answer) "The ball and the sausage weigh the same, because they are both the same size. I am not sure, because I think one weighs more than the other."
Subject: Michelle  Age: 8 - 9  Grade: 3rd.

(answer) "The sausage and the ball will have the same amount of clay, because they have the same amount".

(answer) "They have the same amount, because the sausage is the same as the ball... I am not sure because the sausage is long and the ball is round".

(answer) "The ball and the seven pieces weigh the same. Before, the seven pieces were a ball. I am not sure, I think the seven pieces weigh less and the ball weighs more".

Conservation Stage. Subjects finally reached the stage of equilibrium, no more doubts are present. Children were able to follow transformations without centering their perception in only one aspect of the stimuli. Children, during this final stage, did not change their opinion, no matter all the efforts done by the examiner in order to create a mental disequilibrium. Children maintained and defended their opinion, even though sometimes they could not give elaborated answers. Examples of some student's answers in the conservation stage were:

Subject: Katia  Age: 9 - 11  Grade: 3rd.

(answer) "It will be the same quantity, because the sausage was made from the ball".

(answer) "There is the same amount, before the sausage was a ball and had the same amount. I am sure because the balls weigh the same".

Subject: Francisco  Age: 12 - 8  Grade: 5th.

(answer) "They will weigh the same, because you did not take anything
from the other ball".

(answer) "The ball and the disk weigh the same, because they weighted the same. I weighted them".

Subject: Rosa  Age: 13 - 4  Grade: 6th.

(answer) "The ball and the seven pieces will have the same amount, because both have the same quantity".

(answer) "They have the same amount. The amount did not decrease. I am sure, because before they had the same quantity".

On the conservation stage, children from Sobral gave a variety of reasons to explain their thought. Children usually referred to size, shape and weight. At the same time they used compensation, identity, description of the action, sometimes reversibility as well. Most often children used a general explanation answer, e.g. "the disk and the ball weight the same, because they had the same weight before", "they were the same".

Qualitative Analysis

Type of Explanations

A summary of the classification of children's answers by age per grade according to Elkind's categorization, is presented in Tables 2 through 8. Answers which were classified as "I don't know" (IDK) were not considered in the analysis under the categories of non conservation and conservation. Romancing and perceptual answers were classified as non conservation answers and, specific and general explanation answers as conservation ones. Twelve answers per child were analysed. The
judgement answers were not considered because of being of the "yes or no" kind.

Six and seven year olds at first grade level (Table 2) showed the same trend, about 84% of the answers were non conservation answers and the type of explanations most used were the perceptual ones with no observable difference between six and seven year olds. At the second grade level (Table 3) 65% of the answers were perceptual ones. On the other hand, seven year olds in first grade gave 90% of non conservation responses, that is 25% more non conservation responses than second grade seven year olds, who gave only 65% of non conservation responses.

Table 4 shows that third grade eight year olds gave 10% more conservation responses than non-conservation ones, while nine year old third graders gave equal proportion of non conservation and conservation explanations. Overall, within grade conservation explanations amounted to 53%. Third graders eight year olds gave less number of non-conservation responses than eight year olds attending second grade.

Nine year old children at the fourth grade level (Table 5) did not show much of a difference between non conserving and conserving explanations which were 49 and 51% respectively. Ten year old children showed about 44% conservation explanations and eleven year old children showed almost equal conserving and non conserving answers. Again, when comparing children of same age who attend different grades, that is nine year olds in third and fourth grade showed equivalent percentages of conservation and non conservation explanations.
<table>
<thead>
<tr>
<th>AGE</th>
<th>TYPE OF ANSWER</th>
<th>IDK</th>
<th>Romancing</th>
<th>Perceptual</th>
<th>Total$^a$</th>
<th>NC</th>
<th>Specific</th>
<th>General</th>
<th>Total$^b$</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td></td>
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<td>8</td>
<td>222</td>
<td>230</td>
<td>11</td>
<td>12</td>
<td>23</td>
<td></td>
</tr>
</tbody>
</table>

$^a$ NC = non conservation

$^b$ C = conservation
TABLE 3. Number of answers by type of explanation and age for second grade children

<table>
<thead>
<tr>
<th>AGE</th>
<th>IDK</th>
<th>Romancing</th>
<th>Perceptual</th>
<th>Total&lt;sup&gt;a&lt;/sup&gt;</th>
<th>NC</th>
<th>Specific</th>
<th>General</th>
<th>Total&lt;sup&gt;b&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>4</td>
<td>0</td>
<td>95</td>
<td>95</td>
<td>15</td>
<td>30</td>
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<td>0</td>
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<td>38</td>
<td>19</td>
<td>1</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
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<td>0</td>
<td>133</td>
<td>133</td>
<td>34</td>
<td>31</td>
<td>65</td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup> NC = non conservation
<sup>b</sup> C = conservation
TABLE 4. Number of answers by type of explanation and age for third grade children

<table>
<thead>
<tr>
<th>AGE</th>
<th>TYPE OF ANSWER</th>
<th>IDK</th>
<th>Romancing</th>
<th>Perceptual</th>
<th>Total&lt;sup&gt;a&lt;/sup&gt;</th>
<th>NC</th>
<th>Specific</th>
<th>General</th>
<th>Total&lt;sup&gt;b&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
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</tr>
<tr>
<td>8</td>
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<td>0</td>
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<td>43</td>
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<td>0</td>
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<td>127</td>
<td>67</td>
<td>59</td>
<td>126</td>
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</tr>
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<td>184</td>
<td>110</td>
<td>102</td>
<td>212</td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup> NC = non conservation
<sup>b</sup> C = conservation
TABLE 5. Number of answers by type of explanation and age for fourth grade children

<table>
<thead>
<tr>
<th>AGE</th>
<th>IDK</th>
<th>Romancing</th>
<th>Perceptual</th>
<th>TotalNC</th>
<th>Specific</th>
<th>General</th>
<th>TotalC</th>
</tr>
</thead>
<tbody>
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<td>40</td>
<td>40</td>
<td>34</td>
<td>7</td>
<td>41</td>
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<tr>
<td>10</td>
<td>3</td>
<td>0</td>
<td>165</td>
<td>165</td>
<td>89</td>
<td>45</td>
<td>134</td>
</tr>
<tr>
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<td>0</td>
<td>33</td>
<td>33</td>
<td>21</td>
<td>19</td>
<td>40</td>
</tr>
</tbody>
</table>

| TOTAL| 4   | 0          | 238        | 238     | 144      | 71      | 215    |

\(^a\) NC = non conservation  
\(^b\) C = conservation
TABLE 6. Number of answers by type of explanation and age for fifth grade children

<table>
<thead>
<tr>
<th>AGE</th>
<th>IDK</th>
<th>Romancing</th>
<th>Perceptual</th>
<th>Total&lt;sup&gt;a&lt;/sup&gt;</th>
<th>NC</th>
<th>Specific</th>
<th>General</th>
<th>Total&lt;sup&gt;b&lt;/sup&gt;</th>
<th>C</th>
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</thead>
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<td>0</td>
<td>16</td>
<td>16</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>11</td>
<td>7</td>
<td>0</td>
<td>69</td>
<td>69</td>
<td>83</td>
<td></td>
<td>94</td>
<td>177</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>0</td>
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<td>60</td>
<td>60</td>
<td>74</td>
<td></td>
<td>45</td>
<td>119</td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td>7</td>
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<td>145</td>
<td>145</td>
<td>167</td>
<td></td>
<td>161</td>
<td>328</td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup> NC = non conservation

<sup>b</sup> C = conservation
At the fifth grade level (Table 6) ten year olds showed about 67% of conservation answers and the eleven and twelve year olds showed 70% and 66% of the same type of explanations respectively. Overall fifth graders gave 68% of conservation explanations. A comparison within age group between grade level indicated that ten year olds in fifth grade gave more conservation explanations than ten year olds in fourth grade. The same trend was observed when comparing the eleven year old groups attending fourth and fifth grade.

Sixth graders (Table 7) showed the following patterns of conserving explanations: eleven year olds, 80%; twelve year olds, 79%; and thirteen year olds, 74%. Conservation explanations within grade reach about 77%, being the specific explanation type of answer most commonly used. Eleven year olds sixth graders did marginally better than the eleven year olds fifth graders, while twelve year old sixth graders showed clearly a much greater proportion of conservation responses than the twelve year old fifth graders.

Seventh grade (Table 8), twelve year old children gave equal percentages of non-conserving and conserving explanations. On the other hand, seventh grade thirteen year olds gave about 64% of conserving answers or 10% less conserving answers than the comparable age group attending sixth grade. Within grade, the conserving explanation answers were higher (61%) than the non-conserving ones (35%). Twelve and thirteen year old seventh graders gave more non-conserving answers (35%) than twelve and thirteen year old sixth graders (24%).
TABLE 7. Number of answers by type of explanation and age for sixth grade children

<table>
<thead>
<tr>
<th>AGE</th>
<th>IDK</th>
<th>Romancing</th>
<th>Perceptual</th>
<th>Total\textsuperscript{a}</th>
<th>NC</th>
<th>Specific</th>
<th>General</th>
<th>Total\textsuperscript{b}</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>1</td>
<td>0</td>
<td>16</td>
<td>16</td>
<td>48</td>
<td>22</td>
<td>70</td>
<td>94</td>
</tr>
<tr>
<td>12</td>
<td>0</td>
<td>0</td>
<td>35</td>
<td>35</td>
<td>80</td>
<td>51</td>
<td>131</td>
<td>123</td>
</tr>
<tr>
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<td>43</td>
<td>43</td>
<td>72</td>
<td>51</td>
<td>123</td>
<td>123</td>
</tr>
<tr>
<td>TOTAL</td>
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<td>0</td>
<td>94</td>
<td>94</td>
<td>200</td>
<td>124</td>
<td>324</td>
<td>324</td>
</tr>
</tbody>
</table>

\textsuperscript{a} NC = non conservation  
\textsuperscript{b} C = conservation
TABLE 8. Number of answers by type of explanation and age for seventh grade children

<table>
<thead>
<tr>
<th>AGE</th>
<th>TYPE OF ANSWER</th>
<th>Total&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Total&lt;sup&gt;b&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>IDK</td>
<td>Romancing</td>
<td>Perceptual</td>
</tr>
<tr>
<td>12</td>
<td>0</td>
<td>0</td>
<td>33</td>
</tr>
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<td>13</td>
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<td>0</td>
<td>69</td>
</tr>
<tr>
<td>TOTAL</td>
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<td>0</td>
<td>102</td>
</tr>
</tbody>
</table>

<sup>a</sup> NC = non conservation

<sup>b</sup> C = conservation
It was commonly found, at the conserving stage, that a large number of children used general explanation answers. Children would refer to the original, present or future equality of the balls presented to them before the transformation was carried out. They did not go beyond this type of explanation. Nevertheless, they felt that their explanations were correct and did not change their opinions, e.g. "They are the same"; " Both weigh the same because they were the same ". Perceptual explanations were given more commonly than romancing ones by non conservers and showed a tendency to decrease as children got older or in an advanced grade level. On the other hand, both specific and general explanations were found in conservers. Reversibility answers, e.g. " if you put back together the seven pieces, they would equal the original ball ", were not commonly used among children. Only 84 explanations out of 2,448 answers were of this type.

Percent Conservation

The percentage of conservation responses for mass and weight according to the type of transformation by age level is presented in Table 9. It can be appreciated that in accordance with Elkind's criterion (75%), conservation of substance was achieved at eleven years of age as determined by the sausage and disk transformations. For the seven pieces transformation, conservation of mass was almost achieved at age twelve (71%). Conservation of weight was not achieved at any of the age levels under investigation as determined by the three types of transformations used. However, the higher percentages of conservation responses were achieved at eleven years of age, but none
TABLE 9. Percent of conservation responses for substance and weight according to type of transformation and age level

<table>
<thead>
<tr>
<th>Conservation task</th>
<th>Type of transformation</th>
<th>AGE LEVEL</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
</tr>
</thead>
<tbody>
<tr>
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<td>52</td>
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<td></td>
<td>D</td>
<td></td>
<td>6</td>
<td>22</td>
<td>69</td>
<td>73</td>
<td>63</td>
<td>80</td>
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<td>71</td>
<td>73</td>
</tr>
<tr>
<td>Weight</td>
<td>S</td>
<td></td>
<td>15</td>
<td>22</td>
<td>39</td>
<td>42</td>
<td>49</td>
<td>71</td>
<td>66</td>
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</tr>
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<td>39</td>
<td>46</td>
<td>44</td>
<td>68</td>
<td>66</td>
<td>69</td>
</tr>
</tbody>
</table>

No. of expected conservation responses
- 33 69 51 84 96 93 105 93

No. of subjects
- 11 23 17 28 32 31 35 31

S = Sausage transformation
D = Disk transformation
P = Pieces transformation
reached the 75% criterion.

In this study the percent of conservation responses suggests that the ability to measure the attainment of conservation appears to be affected by the type of transformation used by the experimenter. It seems that sausage and disk transformations have equivalent potential as measuring devices and were easier to conserve than the seven pieces transformation.

From seven to eight years of age there is a qualitative change in conservation development as seen by a dramatic increase in the percentage of conservation responses. From eight to eleven years only gradual increases of conservation responses can be perceived. This observation can be explained when data is presented as the number of subjects in non conservation, transitional and conservation stages within age level and type of transformation (Table 10). The increase in number of subjects in transitional and conservation stages from seven to eight years of age is larger than at any other change of age group. This means that some percentage of individuals within age group starting at eight years of age are already attaining conservation of mass and weight, although the population as a whole shows to attain it at a much older age (eleven years of age).

The qualitative analysis by grade level regarding the percent of conservation answers for mass and weight (Table 11) indicated that first and second graders did not acquire, as a whole, neither conservation of substance nor conservation of weight. While it is shown that third graders acquire conservation of mass (78%) when the disk transformation was used to assess it, the other types of transformations
TABLE 10. Number of subjects in non-conservation (NC), transitional (T), and conservation (C), stages for substance and weight according to type of transformation and age level

<table>
<thead>
<tr>
<th>Conservation tasks</th>
<th>Type of transformation</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
</tr>
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<td>T</td>
<td>C</td>
<td>NC</td>
<td>T</td>
<td>C</td>
<td>NC</td>
<td>T</td>
</tr>
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<td>0</td>
<td>18</td>
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<td>0</td>
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<td></td>
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<td>16</td>
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<td>3</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>Weight</td>
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<td>1</td>
<td>15</td>
<td>6</td>
<td>2</td>
<td>8</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>D</td>
<td>9</td>
<td>2</td>
<td>0</td>
<td>18</td>
<td>3</td>
<td>2</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>P</td>
<td>8</td>
<td>3</td>
<td>0</td>
<td>16</td>
<td>3</td>
<td>4</td>
<td>7</td>
<td>6</td>
</tr>
<tr>
<td>No. of Subjects</td>
<td></td>
<td>11</td>
<td>23</td>
<td>17</td>
<td>28</td>
<td>32</td>
<td>31</td>
<td>36</td>
<td>31</td>
</tr>
</tbody>
</table>

S = Sausage transformation  
D = Disk transformation  
P = Pieces transformation
TABLE 11. Percent of conservation answers for substance and weight by type of transformation and grade level

<table>
<thead>
<tr>
<th>Conservation task</th>
<th>Type of transformation</th>
<th>1st</th>
<th>2nd</th>
<th>3rd</th>
<th>4th</th>
<th>5th</th>
<th>6th</th>
<th>7th</th>
</tr>
</thead>
<tbody>
<tr>
<td>Substance</td>
<td>S</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>D</td>
<td>6</td>
<td>38</td>
<td>78</td>
<td>59</td>
<td>84</td>
<td>80</td>
<td>74</td>
</tr>
<tr>
<td></td>
<td>P</td>
<td>14</td>
<td>42</td>
<td>53</td>
<td>62</td>
<td>70</td>
<td>75</td>
<td>72</td>
</tr>
<tr>
<td>Weight</td>
<td>S</td>
<td>15</td>
<td>29</td>
<td>47</td>
<td>39</td>
<td>68</td>
<td>78</td>
<td>56</td>
</tr>
<tr>
<td></td>
<td>D</td>
<td>3</td>
<td>35</td>
<td>56</td>
<td>41</td>
<td>72</td>
<td>68</td>
<td>51</td>
</tr>
<tr>
<td></td>
<td>P</td>
<td>14</td>
<td>38</td>
<td>43</td>
<td>46</td>
<td>59</td>
<td>77</td>
<td>61</td>
</tr>
</tbody>
</table>

S = Sausage transformation  
D = Disk transformation  
P = Pieces transformation
failed to demonstrate the acquisition of the conservation concepts. Since third graders were the starting grade level at which the subjects showed conservation of mass for the disk transformation, it was expected that fourth graders would show the same pattern. However, this has not been the case. Fifth graders showed the same pattern as described above for third graders. In general fifth graders showed higher absolute percentage values for all transformations than third grade subjects. Sixth grade level subjects showed conservation in all types of transformations except for weight conservation when measured by the disk transformation, when only 68% of conservation responses were recorded. It appeared that the disk transformation in this particular case did not measure the concept of weight as efficiently as the sausage and seven pieces transformations. Seven graders met the criterion only for mass conservation with the sausage transformation and, failed to show to have acquired conservation of weight.

Quantitative Analysis

Sausage Transformation

The least squares hierarchical analysis of variance and the corresponding least squares means obtained for the conservation values of substance and weight as measured with the sausage transformation are presented in Tables 12 and 13. It can be observed that grade level had a significant influence (P < 0.001) on both conservation tasks. A highly significant (P < 0.001) linear regression
TABLE 12. Least squares hierarchical analysis of variance of the conservation scores of substance and weight obtained for the sausage transformation

<table>
<thead>
<tr>
<th>Source of variation</th>
<th>d.f.</th>
<th>Substance</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade</td>
<td>6</td>
<td>18.42***</td>
<td>11.18***</td>
</tr>
<tr>
<td>Linear</td>
<td>1</td>
<td>79.86***</td>
<td>46.22***</td>
</tr>
<tr>
<td>Quadratic</td>
<td>1</td>
<td>23.39***</td>
<td>6.13*</td>
</tr>
<tr>
<td>Cubic</td>
<td>1</td>
<td>0.34</td>
<td>4.72</td>
</tr>
<tr>
<td>Quartic</td>
<td>1</td>
<td>1.21</td>
<td>6.64*</td>
</tr>
<tr>
<td>Quintic</td>
<td>1</td>
<td>3.22</td>
<td>0.01</td>
</tr>
<tr>
<td>Residual</td>
<td>1</td>
<td>2.52</td>
<td>3.38</td>
</tr>
<tr>
<td>Age:Grade 1</td>
<td>10</td>
<td>0.77</td>
<td>1.12</td>
</tr>
<tr>
<td>Age:Grade 2</td>
<td>1</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Age:Grade 3</td>
<td>1</td>
<td>0.01</td>
<td>0.47</td>
</tr>
<tr>
<td>Age:Grade 4</td>
<td>1</td>
<td>0.39</td>
<td>1.25</td>
</tr>
<tr>
<td>Age:Grade 5</td>
<td>2</td>
<td>1.47</td>
<td>0.46</td>
</tr>
<tr>
<td>Age:Grade 6</td>
<td>2</td>
<td>0.34</td>
<td>3.81a</td>
</tr>
<tr>
<td>Age:Grade 7</td>
<td>1</td>
<td>1.14</td>
<td>0.37</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.39</td>
<td>0.22</td>
</tr>
<tr>
<td>Remainder</td>
<td>192</td>
<td>1.08</td>
<td>1.47</td>
</tr>
</tbody>
</table>

- \( R^2 \) = 0.378 for Substance, 0.227 for Weight

- *** (P<0.001)
- * (P<0.05)
- d.f. degrees of freedom
- \( a \) P = 0.07 and significant linear regression (P=0.02)
also indicates that a constant increase of conservation responses can be obtained from students in higher grade levels. The age within grade level variation did not influence the attainment of conservation. The exception being that of age within fifth grade for conservation of weight which showed a tendency to be significant \((P = 0.07)\). However, the effect was such that ten year olds scored better, in absolute terms, than twelve year olds, (Table 13).

Least square means for conservation of substance showed that first and second grade level means were significantly different between them and the rest of grade groups. Third, fourth and fifth graders did not differ in their mean scores nor did fifth, sixth and seventh graders. However, third and fourth graders differed from sixth graders who showed the highest absolute mean among all grade levels. Age group mean scores within grade level, did not show significant differences, excepting age within fourth grade in which eleven year olds showed to have higher mean scores \((P < 0.05)\) than nine and ten year olds. When comparing mean scores of same age groups that attend different grade levels it was observed that seven year olds in second grade scored higher than seven year olds in first grade. The same trend was observed for similar comparisons of other age groups and grade levels.

Mean conservation scores for weight obtained with the sausage transformation showed that first graders did not score differently than second graders but were very different \((P < 0.05)\) from all other grade level groups. Also, second, third, fourth and seventh graders mean scores did not differ among them but all differed from
TABLE 13. Least squares means by grade and age within grade of the conservation scores of substance and weight obtained for the sausage transformation

<table>
<thead>
<tr>
<th>Source of variation</th>
<th>Classes&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Substance</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>u</td>
<td>-</td>
<td>1.63</td>
<td>1.45</td>
</tr>
<tr>
<td>Grade</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>0.00 (0.000)&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.45 (0.258)&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>0.78 (0.276)&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1.02 (0.322)&lt;sup&gt;ab&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>1.97 (0.188)&lt;sup&gt;c&lt;/sup&gt;</td>
<td>1.37 (0.219)&lt;sup&gt;b&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>1.81 (0.205)&lt;sup&gt;c&lt;/sup&gt;</td>
<td>1.21 (0.239)&lt;sup&gt;b&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>2.22 (0.178)&lt;sup&gt;cd&lt;/sup&gt;</td>
<td>2.16 (0.208)&lt;sup&gt;c&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>2.51 (0.185)&lt;sup&gt;d&lt;/sup&gt;</td>
<td>2.35 (0.216)&lt;sup&gt;c&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>2.11 (0.245)&lt;sup&gt;cd&lt;/sup&gt;</td>
<td>1.61 (0.285)&lt;sup&gt;bc&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>Grade:Age</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grade 1</td>
<td>6</td>
<td>0.00 (0.000)&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.45 (0.365)&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>7</td>
<td>0.00 (0.000)&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.45 (0.365)&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>Grade 2</td>
<td>8</td>
<td>0.75 (0.299)&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.83 (0.349)&lt;sup&gt;ab&lt;/sup&gt;</td>
</tr>
<tr>
<td>9</td>
<td>0.80 (0.464)&lt;sup&gt;bc&lt;/sup&gt;</td>
<td>1.20 (0.541)&lt;sup&gt;bcde&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>Grade 3</td>
<td>8</td>
<td>2.08 (0.299)&lt;sup&gt;defg&lt;/sup&gt;</td>
<td>1.17 (0.349)&lt;sup&gt;abcdef&lt;/sup&gt;</td>
</tr>
<tr>
<td>9</td>
<td>1.86 (0.227)&lt;sup&gt;d&lt;/sup&gt;</td>
<td>1.57 (0.264)&lt;sup&gt;abc&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>Grade 4</td>
<td>9</td>
<td>1.43 (0.393)&lt;sup&gt;cd&lt;/sup&gt;</td>
<td>1.00 (0.458)&lt;sup&gt;bcd&lt;/sup&gt;</td>
</tr>
<tr>
<td>10</td>
<td>1.66 (0.208)&lt;sup&gt;cd&lt;/sup&gt;</td>
<td>1.12 (0.242)&lt;sup&gt;abc&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>2.33 (0.424)&lt;sup&gt;efg&lt;/sup&gt;</td>
<td>1.50 (0.494)&lt;sup&gt;bcdefg&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>Grade 5</td>
<td>10</td>
<td>2.29 (0.393)&lt;sup&gt;defg&lt;/sup&gt;</td>
<td>2.71 (0.458)&lt;sup&gt;efgh&lt;/sup&gt;</td>
</tr>
<tr>
<td>11</td>
<td>2.06 (0.245)&lt;sup&gt;defg&lt;/sup&gt;</td>
<td>2.22 (0.285)&lt;sup&gt;efgh&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>2.33 (0.268)&lt;sup&gt;efg&lt;/sup&gt;</td>
<td>1.53 (0.312)&lt;sup&gt;efgh&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>Grade 6</td>
<td>11</td>
<td>2.71 (0.393)&lt;sup&gt;fg&lt;/sup&gt;</td>
<td>2.43 (0.457)&lt;sup&gt;efgh&lt;/sup&gt;</td>
</tr>
<tr>
<td>12</td>
<td>2.67 (0.268)&lt;sup&gt;defg&lt;/sup&gt;</td>
<td>2.47 (0.313)&lt;sup&gt;efgh&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>2.15 (0.288)&lt;sup&gt;defg&lt;/sup&gt;</td>
<td>2.15 (0.336)&lt;sup&gt;efgh&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>Grade 7</td>
<td>12</td>
<td>1.83 (0.424)&lt;sup&gt;efg&lt;/sup&gt;</td>
<td>1.50 (0.494)&lt;sup&gt;efgh&lt;/sup&gt;</td>
</tr>
<tr>
<td>13</td>
<td>2.39 (0.245)&lt;sup&gt;efg&lt;/sup&gt;</td>
<td>1.72 (0.285)&lt;sup&gt;def&lt;/sup&gt;</td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup>Class numbers for the grade source of variation correspond to grade levels in increasing order. Class numbers for age:grade source of variation correspond to the real average age, in years, of the experimental subjects.

(s.e.) One standard error of the mean.

Note: Mean (s.e.) values with different superscript, within source of variation and within column, are significantly different (<i>P</i> < 0.05).
fifth and sixth graders. No difference was found between the latter two groups and sixth graders again showed the highest absolute mean score.

Comparisons of mean scores between or among age groups within grade level for all grade level groups did not show statistical differences, the exception being that of fifth grade where ten year olds showed higher (P < 0.05) scores than twelve year olds. When comparing between or among same age groups in different grade levels it was observed that fourth grade ten year olds scored significantly lower (P < 0.05) than fifth grade ten year olds. This latter group scored statistically equal to the fifth and sixth grade eleven year olds and sixth grade twelve and thirteen year olds but higher (P < 0.05) than any other age group including the seventh grade twelve and thirteen year olds.

Disk Transformation

Results of the Least Squares Hierarchical analysis of variance and their corresponding least squares mean values for conservation of substance and weight attained by the use of the Disk Transformation are presented in Tables 14 and 15 respectively.

The Hierarchical analysis of variance for both types of quantities evaluated showed the same tendencies as observed with the sausage transformation. Grade level has a significant effect (P < 0.001) on the attainment of conservation while the age within grade effect did not exert any influence on it. Again, a significant (P < 0.001) linear and quadratic effects of grade on attainment of conservation were
TABLE 14. Least squares hierarchical analysis of variance of the conservation scores of substance and weight obtained for the disk transformation

<table>
<thead>
<tr>
<th>Source of variation</th>
<th>d.f.</th>
<th>Substance</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Grade</strong></td>
<td>6</td>
<td>18.08***</td>
<td>13.03***</td>
</tr>
<tr>
<td>Linear</td>
<td>1</td>
<td>65.98***</td>
<td>41.13***</td>
</tr>
<tr>
<td>Quadratic</td>
<td>1</td>
<td>29.92***</td>
<td>25.08***</td>
</tr>
<tr>
<td>Cubic</td>
<td>1</td>
<td>2.19</td>
<td>0.23</td>
</tr>
<tr>
<td>Quartic</td>
<td>1</td>
<td>0.14</td>
<td>3.56</td>
</tr>
<tr>
<td>Quintic</td>
<td>1</td>
<td>0.72</td>
<td>0.03</td>
</tr>
<tr>
<td>Residual</td>
<td>1</td>
<td>9.54**</td>
<td>8.12*</td>
</tr>
<tr>
<td><strong>Age:Grade</strong></td>
<td>10</td>
<td>0.49</td>
<td>0.78</td>
</tr>
<tr>
<td>Age:Grade 1</td>
<td>1</td>
<td>0.00</td>
<td>0.18</td>
</tr>
<tr>
<td>Age:Grade 2</td>
<td>1</td>
<td>0.02</td>
<td>0.00</td>
</tr>
<tr>
<td>Age:Grade 3</td>
<td>1</td>
<td>0.52</td>
<td>2.09</td>
</tr>
<tr>
<td>Age:Grade 4</td>
<td>2</td>
<td>1.02</td>
<td>0.98</td>
</tr>
<tr>
<td>Age:Grade 5</td>
<td>2</td>
<td>0.47</td>
<td>1.48</td>
</tr>
<tr>
<td>Age:Grade 6</td>
<td>2</td>
<td>0.70</td>
<td>0.12</td>
</tr>
<tr>
<td>Age:Grade 7</td>
<td>1</td>
<td>0.00</td>
<td>0.35</td>
</tr>
<tr>
<td><strong>Remainder</strong></td>
<td>192</td>
<td>1.23</td>
<td>1.62</td>
</tr>
<tr>
<td><strong>R²</strong></td>
<td></td>
<td>0.333</td>
<td>0.217</td>
</tr>
</tbody>
</table>

*** (P<0.001)  
** (P<0.01)  
* (P<0.05)  
d.f. degrees of freedom
A constant increment of conservation scores is attained at higher grade levels.

Least squares means for conservation of substance indicated that first grade subjects scored the lowest values among all grade levels, followed by second graders who scored higher than first graders but lower than any of the other remaining grades. Fourth graders scored relatively better than first and second graders, equal to seventh graders but poorer than third, fourth and fifth graders. The latter three grades scored equally and better than all grades with fifth graders showing the highest absolute mean score.

The age within grade level did not show significant differences between age groups at any of the grade levels analysed. However a comparison of same age groups between different grade levels showed that seven year olds in second grade did better than seven year olds in first grade, in turn eight year olds in third grade performed better than the ones in second grade. There was no difference observed between nine year olds in third and fourth grade. On the other hand ten year olds in fifth grade had higher scores than ten year olds in fourth grade. No difference was detected for any other age group between grade levels. In general when an age group was better than a similar age group in a different grade level, this age group was in an advance grade. Hence, reinforcing the grade effect on the attainment of conservation.

Least squares means for conservation of weight as by the disk transformation indicated that fifth and sixth graders scored the highest among all grade levels studied followed by third, seventh...
TABLE 15. Least squares means by grade and age within grade of the conservation scores of substance and weight obtained for the disk transformation.

<table>
<thead>
<tr>
<th>Source of variation</th>
<th>Classes</th>
<th>Substance</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1.83</td>
<td>1.42</td>
</tr>
<tr>
<td>u</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grade</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>0.18 (0.236)(^a)</td>
<td>0.09 (0.271)(^a)</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>1.04 (0.295)(^b)</td>
<td>1.00 (0.338)(^b)</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>2.37 (0.200)(^d)</td>
<td>1.74 (0.229)(^cd)</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>1.92 (0.220)(^c)</td>
<td>1.33 (0.251)(^bc)</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>2.59 (0.189)(^d)</td>
<td>2.25 (0.218)(^e)</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>2.39 (0.197)(^d)</td>
<td>2.05 (0.227)(^de)</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>2.33 (0.260)(^cd)</td>
<td>1.47 (0.299)(^bc)</td>
<td></td>
</tr>
<tr>
<td>Age:Grade</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grade 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>0.18 (0.334)(^a)</td>
<td>0.18 (0.383)(^a)</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>0.18 (0.334)(^a)</td>
<td>0.00 (0.000)(^a)</td>
<td></td>
</tr>
<tr>
<td>Grade 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>1.08 (0.319)(^b)</td>
<td>1.00 (0.367)(^b)</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>1.00 (0.494)(^ab)</td>
<td>1.00 (0.368)(^b)</td>
<td></td>
</tr>
<tr>
<td>Grade 3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>2.50 (0.319)(^de)</td>
<td>2.00 (0.367)(^cd)</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>2.24 (0.241)(^de)</td>
<td>1.48 (0.277)(^bc)</td>
<td></td>
</tr>
<tr>
<td>Grade 4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>2.00 (0.418)(^cd)</td>
<td>1.71 (0.480)(^bc)</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>1.60 (0.221)(^bc)</td>
<td>1.12 (0.254)(^bc)</td>
<td></td>
</tr>
<tr>
<td>Grade 5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>2.17 (0.452)(^de)</td>
<td>1.17 (0.518)(^bc)</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>2.86 (0.418)(^e)</td>
<td>2.71 (0.480)(^d)</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>2.44 (0.261)(^de)</td>
<td>2.11 (0.299)(^cd)</td>
<td></td>
</tr>
<tr>
<td>Grade 6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>2.47 (0.286)(^de)</td>
<td>1.93 (0.328)(^cd)</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>2.43 (0.418)(^cde)</td>
<td>2.14 (0.480)(^cd)</td>
<td></td>
</tr>
<tr>
<td>Grade 7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>2.33 (0.452)(^cde)</td>
<td>1.33 (0.519)(^bc)</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>2.33 (0.261)(^cde)</td>
<td>1.61 (0.299)(^bc)</td>
<td></td>
</tr>
</tbody>
</table>

\(^a\) Class numbers for the grade source of variation correspond to grade levels in increasing order. Class numbers for age:grade source of variation correspond to the real average age, in years, of the experimental subjects.

(s.e.) One standard error of the mean.

Note: Mean (s.e.) values with different superscript, within source of variation and within column, are significantly different (P<0.05).
and fourth graders, in that order, who scored similarly among them, lower than the formers and higher than second and first graders who were different between them and had the lowest scores. Comparison of least squares means between age groups within grade level did not show statistical differences for all age levels within all grade levels studied.

When comparing same age group from different grade levels, it was observed that seven, eight and ten year olds attending a higher grade level performed better than their comparable age groups attending a lower grade level. Comparisons between grade levels of other age groups did not show differences among them.

Seven Pieces Transformation

The least squares hierarchical analysis of variance (Table 16) showed that grade level influence significantly ($P < 0.001$) the attainment of conservation of substance and weight and that conservation is increasingly achieved as subjects are promoted from a lower to a higher grade, as it is indicated by a significant ($P < 0.001$) linear regression. On the other hand, age within grade did not show any influence on the acquisition of conservation.

Least squares means obtained for conservation of substance and weight by means of the seven pieces transformation are presented in Table 17. Sixth, fifth, fourth and seventh graders conserved substance at an statistically equivalent level, which was higher than second and first graders, while third graders did not differ from second, fourth and fifth graders. Highest absolute score
TABLE 16. Least squares hierarchical analysis of variance of the conservation scores of substance and weight obtained for the seven pieces transformation

<table>
<thead>
<tr>
<th>Source of variation</th>
<th>d.f.</th>
<th>Substance</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade</td>
<td>6</td>
<td>10.00***</td>
<td>9.52***</td>
</tr>
<tr>
<td>Linear</td>
<td>1</td>
<td>44.47***</td>
<td>47.74***</td>
</tr>
<tr>
<td>Quadratic</td>
<td>1</td>
<td>14.60**</td>
<td>2.89</td>
</tr>
<tr>
<td>Cubic</td>
<td>1</td>
<td>0.04</td>
<td>0.55</td>
</tr>
<tr>
<td>Quartic</td>
<td>1</td>
<td>0.48</td>
<td>4.91</td>
</tr>
<tr>
<td>Quintic</td>
<td>1</td>
<td>0.06</td>
<td>0.66</td>
</tr>
<tr>
<td>Residual</td>
<td>1</td>
<td>0.37</td>
<td>0.36</td>
</tr>
<tr>
<td>Age:Grade 1</td>
<td>1</td>
<td>1.14</td>
<td>0.05</td>
</tr>
<tr>
<td>Age:Grade 2</td>
<td>1</td>
<td>0.19</td>
<td>0.14</td>
</tr>
<tr>
<td>Age:Grade 3</td>
<td>1</td>
<td>1.82</td>
<td>0.35</td>
</tr>
<tr>
<td>Age:Grade 4</td>
<td>2</td>
<td>1.35</td>
<td>0.87</td>
</tr>
<tr>
<td>Age:Grade 5</td>
<td>2</td>
<td>0.12</td>
<td>0.27</td>
</tr>
<tr>
<td>Age:Grade 6</td>
<td>2</td>
<td>0.82</td>
<td>0.51</td>
</tr>
<tr>
<td>Age:Grade 7</td>
<td>1</td>
<td>2.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Remainder</td>
<td>192</td>
<td>1.58</td>
<td>1.68</td>
</tr>
</tbody>
</table>

\[ R^2 \]  

\[ \bar{R}^2 \]  

\[ 0.194 \]  

\[ 0.166 \]  

*** (P<0.001)  
** (P<0.01)  
* (P<0.05)  

d.f. degrees of freedom
TABLE 17. Least squares means by grade and age within grade of the conservation scores of substance and weight obtained for the seven pieces transformation

<table>
<thead>
<tr>
<th>Source of variation</th>
<th>Classes&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Substance</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>u</td>
<td>-</td>
<td>1.68</td>
<td>1.46</td>
</tr>
<tr>
<td>Grade</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>0.41 (0.267)&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.41 (0.102)&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>1.28 (0.334)&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1.10 (0.344)&lt;sup&gt;ab&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>1.67 (0.227)&lt;sup&gt;bc&lt;/sup&gt;</td>
<td>1.27 (0.234)&lt;sup&gt;bc&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>2.05 (0.247)&lt;sup&gt;cd&lt;/sup&gt;</td>
<td>1.50 (0.255)&lt;sup&gt;bc&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>2.10 (0.215)&lt;sup&gt;cd&lt;/sup&gt;</td>
<td>1.73 (0.222)&lt;sup&gt;bc&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>2.30 (0.223)&lt;sup&gt;d&lt;/sup&gt;</td>
<td>2.36 (0.231)&lt;sup&gt;d&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>2.00 (0.295)&lt;sup&gt;d&lt;/sup&gt;</td>
<td>1.83 (0.305)&lt;sup&gt;d&lt;/sup&gt;</td>
<td></td>
</tr>
</tbody>
</table>

Age:Grade

| Grade 1 | 6 | 0.64 (0.378)<sup>ab</sup> | 0.45 (0.390)<sup>ab</sup> |
|         | 7 | 0.18 (0.378)<sup>a</sup>  | 0.36 (0.390)<sup>ag</sup> |
| Grade 2 | 7 | 1.17 (0.362)<sup>bc</sup> | 1.00 (0.373)<sup>abc</sup> |
|         | 8 | 1.40 (0.561)<sup>bodf</sup> | 1.20 (0.579)<sup>bodeg</sup> |
| Grade 3 | 8 | 1.92 (0.362)<sup>de</sup>  | 1.17 (0.373)<sup>bod</sup> |
|         | 9 | 1.43 (0.274)<sup>cd</sup>  | 1.38 (0.282)<sup>cdf</sup> |
| Grade 4 | 9 | 2.14 (0.474)<sup>efg</sup> | 1.43 (0.489)<sup>bodef</sup> |
|         | 10| 1.68 (0.251)<sup>ode</sup> | 1.24 (0.259)<sup>bodf</sup> |
|         | 11| 2.33 (0.512)<sup>fg</sup>  | 1.83 (0.528)<sup>dejk</sup> |
| Grade 5 | 10| 2.14 (0.474)<sup>efg</sup> | 1.57 (0.489)<sup>dehf</sup> |
|         | 11| 2.17 (0.296)<sup>efg</sup> | 1.89 (0.305)<sup>dehf</sup> |
|         | 12| 2.00 (0.324)<sup>efg</sup> | 1.73 (0.334)<sup>odehf</sup> |
| Grade 6 | 11| 2.57 (0.474)<sup>g</sup>   | 2.57 (0.489)<sup>j</sup>   |
|         | 12| 2.33 (0.324)<sup>fg</sup>  | 2.13 (0.334)<sup>ej</sup>  |
|         | 13| 2.00 (0.348)<sup>bodg</sup> | 2.38 (0.359)<sup>hj</sup>  |
| Grade 7 | 12| 1.67 (0.512)<sup>bodg</sup> | 1.83 (0.529)<sup>dejk</sup> |
|         | 13| 2.33 (0.296)<sup>fg</sup>  | 1.83 (0.305)<sup>de</sup>  |

<sup>a</sup>Class numbers for the grade source of variation correspond to grade levels in increasing order. Class numbers for age:grade source of variation correspond to the real average age, in years, of the experimental subjects.

(s.e.) One standard error of the mean.
Note: Mean (s.e.) values with different superscript, within source of variation and within column, are significantly different (P<0.05).
was obtained by sixth graders. In general, scores achieved by different age groups within same grade level did not differ statistically among them. However, within fourth grade level, ten year olds did worse than eleven year old while showing an equivalent performance as nine year olds in the same grade level.

As indicated before for the sausage and disk transformation, same age group between grade level comparisons showed that seven, eight and nine year olds attending a higher grade level have higher conservation scores than their comparable groups at a lower grade level. No difference was found among ten, eleven, twelve and thirteen year olds.

Least squares means for weight conservation were the highest among sixth and seventh graders, with sixth graders scores being different than the rest of grade groups. First and second graders scored the lowest among all groups. On the other hand, third, fourth, fifth and seventh graders showed statistically equivalent scores among them. A progressive increment in conservation scores is observed from first to sixth grade. Comparisons between age groups within grade level and same age group between grade levels did not show statistical differences. The only exception to the rule was that eleven year olds in sixth grade outperformed eleven year olds in fifth and fourth grade.

Combined Results.

Conservation of substance and weight are significantly influenced by grade level, and this effect is independent from type of
transformation since it was a significant effect for all of them. First, second, third and seventh grade subjects showed lower scores, as a rule, than fourth, fifth and sixth graders. Age within grade does not influence the attainment of conservation as measured in this study. However, subjects belonging to groups of the same age but attending different grade levels showed that the group attending the higher grade level performed better.
Structure of the Sample

According to the statistics reported in the Plano Estadual de Educacao 1979 - 1983 of Ceara (Educational Plan for the State of Ceara, 1979 -1983), the population of students in Sobral was distributed as follows: of 27,253 children between 7 and 14 years of age who lived in the urban and rural areas of Sobral, 14,670 or 54% registered to attend school during 1975 (latest reported statistics). Thirty-eight percent attended state schools, 34% private schools, 27% town municipal schools and 1% attended federal schools. Student-teacher ratios were 21:1, 26:1, and 25:1 for the private, state and municipal school systems respectively. Some private schools take, as part of their own policies, some socio-economically underprivileged children to whom free education is provided.

The choosing of a private school, as the setting for this study, was based on the fact that it would be located in the urban area of the city and it would include subjects with almost the same socio-economic background as a means of insuring that subjects have gone through, for the most part of their lives, without obstacles that would undermine their physiological development. A fact which is not guaranteed for all students attending state or municipal schools and much less for students in rural areas.

A total of 269 students were interviewed. Sixty were not considered
as part of the sample for the following reasons: 30 participated in the pilot study, 10 were grade repeaters, 16 suspected to be repeaters or that started school at an older age and 4 students belonged to a different socio-economic status.

According to the available statistics for the state of Ceará (IBGE, 1983), it is expected that on the average only 0.06% of the first grade registered students would finish 7th grade. This means that the average number of children per class would be reduced at advanced grade levels. However, this distortion was not observed in our sample, where third, fourth, fifth and sixth graders were the largest groups and of comparable numbers among grades. On the other hand, one distortion was apparent, and it relates to the 2.8:1 female to male sex ratio. Although in the overall population of the state of Ceará the female to male ratio is 1:1, the proportion of female to males in school registration is 1.3:1 for the 10 to 14 year old population (IBGE, 1983). This sex distortion might be explained on the basis that the sampled school may attract more female than male students, due to the fact that it is administered by a catholic nun congregation.

Effect of Sex on the Attainment of Conservation.

Since female subjects were more numerous than male ones, it was decided that the qualitative analysis of data considering the sex variable would not be meaningful. It was later confirmed by the quantitative analysis that the sex variable did not have any effect on the attainment of conservation. Price (1978) in a review on how the sex
variable has been treated on conservation literature, concluded that overall results are not consistent. Prince (1968) found contradicting results in a sample of children from Papua, New Guinea. His study included four schools which were grouped according to type of curriculum and reported to have found sex differences within schools that implemented a modern intensive mathematical curriculum while no sex difference was found in schools that had more traditional education.

Our results are in agreement with those of Heron and Dowel (1973) and, Lewis and Muldard (1974) who indicated that sex did not influence the attainment of conservation in their sampled populations. Bat-Haee (1971) reported no sex difference in children from Missouri and Kiminyo (1977) also did not find sex differences in Kamba children. However, Rawlison (1974) working with Tasmanian children and Goldschmid (1964) working with Californian children reported that male subjects performed better on several different conservation tasks.

Stages and Types of Explanation.

The general hypothesis that the population of children from Sobral will follow the developmental stages to attain conservation, as proposed by Piaget was confirmed. Students were categorized for each type of transformation on the non conservation, transitional and conservation stages. A clear trend was observed that as age increased the amount of conservation also increased. Hence, this observation supports the hypothesis of the existence of a positive correlation between age level and acquisition of conservation. Gil Gaudia (1972), Elkind (1961),
Kamara and Easley (1977), Za'rour (1971) and de Lemos (1969) found the same sequence of developmental stages.

At a younger age perceptual judgements were not in accordance to reality. In the transitional stage, children primarily showed doubts and lack of equilibrium while in the conservation stage students showed their ability to justify their responses free of the perceptual factor.

Children's explanations in this study were similar to other groups studied in western and nonwestern cultures and countries. Generally speaking it appeared that given the conservation tasks (substance and weight) to an individual in any social setting regardless where it is, they will explain and figure out the task in a similar manner. Hence, the operational structures appeared to be universal. In regard to the type of responses de Lemos (1969) wrote that certain answers that children gave like "because it is strong" (p. 264) are not the type of answers which can be taught, therefore they are independent of the cultural environment. The same researcher citing the work of Hyde (1959) states that..."Arab, Indian and Somali children living in Aden showed the same type of responses as those described by Piaget, often given explanations in Arabic which were almost word for word translations of the explanations given by Swiss children (de Lemos, 1969; p.264).

Conservation Sequence

Piaget's findings that conservation of weight follows conservation of substance has been demonstrated in this and other studies(Elkind, 1961; Goldschmid, 1967; Goldschmid and Bentler, 1968; Uzgiris, 1964; and Smedslund, 1961).
Conservation of substance was first observed at third grade level while conservation of weight was observed at the sixth grade level. On the other hand, when the sample was grouped by age conservation of substance first appeared at eleven years of age while conservation of weight was not detected at levels of 75% of conservation responses. Hence suggesting that grade level exercises a greater effect on attainment of conservation than age does.

Effect of Grade Level on Attainment of Conservation.

As it was already indicated the conservation of mass was first attained at the third grade level (Table 11). Mass conservation was detected when the disk transformation was used while the other two type of transformations failed to demonstrate it at the same grade level. Thirty percent of third grade children were 8 year olds and the remainder were 9 years of age. An equivalent proportion of 8 and 9 year olds (about 57% of the subjects) showed to have achieved conservation of mass, 30% were on the transitional stage and 13% did not conserve at all. The sampled population of 8 and 9 year olds of third grade level outperformed, on the average, the sample of all eight or nine year olds when the latter two are grouped by age level independent of grade level. The quantitative analysis of the data collected further supports the significance of the grade effect on the attainment of conservation (Tables 12, 14, 16). If in fact it is necessary that, on the average, a child needs schooling (grade level) to develop cognitive skills (mass and weight) and on the other hand eight and nine year olds have
demonstrated the potential of acquisition of conservation then environmental causes as a whole might not be adequate in promoting and stimulating or challenging enough to promote such development in our particular sample.

Fourth graders did not show a similar percentage of conservation responses as third graders. Thus, as a whole they did not achieve conservation of mass. However, when fourth graders are analysed from a different perspective, ten and nine year olds females did very poorly as compared to the nine and ten year old male group. In fact this result appears to be caused by a sample distortion. The pattern of concept development is again observed at fifth and sixth grade levels when using the disk transformation. At sixth grade level the other two transformations appeared to start measuring what they ought to measure. Also, conservation of weight was achieved by six graders, while a sampling distortion might be influencing the results obtained with seventh graders.

Effect of Age on Attainment of Conservation.

Results of this study regarding the age at which students from Sobral acquire conservation of substance and weight are not consistent with those suggested by Piaget (1941), Elkind (1961), Kiminyo (1977) and other investigators but seemed to show consistency with some cross-cultural research that showed slower development and the intervention of other variables in the attainment of conservation concepts (de Lemos, 1969; Fahrmeier, 1978; Greenfield, 1966; Price, 1978; Prince, 1968;
Za'rour, 1971). The age effect raises again one important question already been asked by previous researchers about other populations. Why did the Sobral students, as a whole, who have so many positive aspects to their every day lives not acquire the concept of conservation of substance and weight at a younger age? Several factors might have influenced this outcome, i.e., the type of school (curriculum) and the socio-cultural environment.

The type of schooling of the particular school attended by the subjects of this sample helped, indeed, to develop perceptual and logical skills but the curriculum appeared to be lacking very important elements and failed to provide enough opportunities, for the students, to develop all their cognitive potential.

A comparison between schooled and non schooled children led Landerau-Bendavid (in Dasen, 1977), to conclude that school experience was an important variable to take into account. The same author indicated that the socio-cultural factor is important but not decisive in cognitive development. In essence the effect of culture and school could either help to speed up or to slow down mental developmental processes.

Greenfield (1966) using Wolof and Senegal children and Prince (1968) in New Guinea found and supported that grade level was indeed a significant variable. Prince (1968) reported..."there is a clear evidence, with the strongest supporting impressions from interviews and all kinds of experiences, that environment is a powerful factor in determining the progress of conceptual development" (p. 73). de Lemos
(1969) quoting Scott, et al. hypothesis of "critical periods" (p. 267) wrote that not only schooling is important but the age when the child entered school. In the same trend Fahrmeir (1978) considered school a significant factor only if the curriculum is developed with "specific elements".

The family environment already described in Chapter Three which surrounds the subjects who participated in this study may have influenced the slow development of conservation tasks. This author believes that maternal child rearing practices are very important and make a difference in the children's cognitive growth. Even though maternal child rearing practices have not been considered in this work, previous studies reported in the literature have proved their influence on conservation (Kirk, 1970; and Adjei, 1973). To further prove the importance of the immediate environment during the most crucial years of development, it has been demonstrated that the influence of caretakers on the rate of language acquisition is significant (Cross, 1975, 1978; Newpor et al. 1975, 1977). The importance of the home environment variable on the development of conservation concepts in subjects from Sobral should be assessed in future studies.

Subjects' lack of experience in a testing situation is another important variable which might have influenced their performance on conservation tasks. Students who participated in this study did not have much experience in a testing situation which is certainly a situation out of context in their every day routines. Carraher and Schileman (1985) underlined the importance of the meaning of a problem, when the individual engages in a problem-solving situation and its
effect on the procedures the individual will use to solve the task. Schileman (1984) further emphasized the fact that problem situations should be related to every day work experiences.

The assessment of our hypothesis which stated that older children in the same grade level will give significantly more conserving responses than younger ones, was evaluated through a statistical analysis of variance which indicated that age within grade did not influence the attainment of conservation. However, least squares mean comparisons suggested that there was some tendency towards significance when the sausage transformation was used to measure substance acquisition in fourth graders. It was found that eleven year olds performed better, meaning that they gave more conserving responses than nine and ten year olds. However, when using the same type of transformation to measure weight acquisition, fifth grade ten year olds gave higher proportion of conserving responses than twelve year olds. Thus, exactly the opposite of what was observed in fourth grade. In substance acquisition, the seven pieces transformation indicated that fourth grade ten year olds did worse than either the eleven or the nine year olds. On the other hand, the disk transformation did not detect any age effect in any of the grade levels analysed. Since only three out of 42 age-grade-transformation subclass groups have shown age within grade effects on acquisition of conservation we tend to think that those were due to sampling effects.
Type of Transformation.

All three transformations used in this study were expected to give similar results. However, the disk transformation showed to be effective in detecting substance conservation at an earlier grade level than did the other two transformations. On the other hand, the disk transformation did not detect conservation of weight while the sausage and seven pieces transformations did. Similar observations with regard to the effect of type of transformation on attainment of conservation has been reported by Goldschmid (1967) who was led to conclude that the level of conservation might be a function of both the task involved and the specific transformation of the objects used.
CHAPTER VI

CONCLUSIONS

The non conservation, transitional and conservation sequential stages, as predicted by Piaget's theory were obtained by the Sobral sample. The same type of explanations for phenomena as described by Piaget and later confirmed by several researchers, were also found. This study as well as perusal of research carried out in other parts of the world (western and non western countries) confirm the universality of the concrete operations which are normally involved in the attainment of the concept of conservation of substance and weight.

Grade level had the most significant (P 0.001) influence in the attainment of conservation of substance and weight, while sex, age and age within grade effects were not significant (P 0.05).

The type of transformation used appeared to have influenced the assessment of the acquisition of conservation concepts. In this regard, the disk transformation was most effective when measuring conservation of substance while the sausage and seven pieces transformations apparently assessed better the conservation of weight. The effect of type of transformation on assessment of conservation needs to be further investigated.

Recommendations for Research

Based upon results of this study the following recommendations for research and practical purposes are suggested:

- Cultural and environmental factors (teacher training,
methodology and curriculum) need to be taken in consideration when designing research studies.

- Alternate type of transformations in conjunction with the ones used in this study, should be investigated in order to find out one that is free of cultural bias which might be able to assess the conservation concepts at an earlier age can also be used to validate our findings.

- School children up to 16 or more years of age should be included in future conservation research, then it will be possible to find out when the population as a whole acquires conservation of weight.

- Future research assessing the effect of the socio-economic variable should provide information about other groups in Sobral. It will be of extreme importance to evaluate when children from more deprived environments acquire conservation concepts in order to readjust their curricula or implement corrective needed measures.

- Cross-Cultural research in the cognitive development area, with special emphasis on Piaget's theory, is important. It may provide data about children from Sobral which could be of use in designing their educational curriculum.

- Since the potential to acquire conservation concepts at eight or nine years of age by some students has been detected, it seems that effecting environmental changes might help students to develop all their cognitive skills at an earlier age than the average found in this study. In this sense when all the necessary information is available it will be possible to adjust curricula in such a way as to benefit students and prepare them to perform well in competitive situations.
BIBLIOGRAPHY


APPENDIX

Appendix A: Research Instrument, English Version

Background Data: Name, age, sex, date of birth, and date of interview.

Material Identification

clay ( )
don't know ( )
other ( )

Agreement of Equality

Examiner presents to the child 4 equal balls made of clay (same size, shape and weight). The child is then asked to choose from the four balls any two that are the same.

- Is there the same amount (quantity) of mass in the two balls?
  
  Are they equal?

  Agrees ( )

If there is doubt, the examiner asks the child to make the balls exactly the same (size, shape and weight) by adding or taking clay away. After the child has ascertained the equality of the two balls, the examiner will proceed.

FIRST PART

- Suppose I make this ball here into a sausage, what will happen?
- Will there be the same amount of clay in the ball as in that sausage?

Answer......................................................
Why? .................................................................
- Will the weight of the sausage be the same as the weight of this ball?
Answer.................................................................
Why?.................................................................

Shape of Sausage

Examiner will ask the child to transform one of the balls into a sausage. If child does not do it, the Examiner will perform the transformation in front of the child.

   Is there the same amount of clay in the ball as in the sausage?
   What do you think?
   More in the sausage () more in the ball () same ()
   Why? .................................................................
   Are you sure? .................................................................

2. Conservation of weight.
   Are the sausage and the ball equally heavy? Do they weigh the same?
   more in the ball () more in the sausage () same ()
   Why?.................................................................
   Are you sure?.................................................................
SECOND PART

Examiner asks the child to transform the sausage into a ball again and make the two balls exactly the same (size, shape and weight).

Agrees ()

After the child has ascertained the equality of the two balls, the examiner will proceed.

Suppose I make this ball here into a disk, what will happen?
Will there be the same amount of clay in the disk as in the ball?
Answer .................................................................
Why? ...........................................................................
Will the weight of this ball be the same as the weight of this disk?
Answer .................................................................
Why? ...........................................................................

Shape of Disk

Examiner will ask the child to transform one of the balls into a disk. If the child does not do it, the Examiner will perform the transformation in front of the child.

1. Conservation of substance

Is there the same amount of clay in the disk as in the ball? What do you think?

more in the ball () more in the disk () same ()

Why? ...........................................................................
Are you sure? .............................................................
2. **Conservation of weight**

Are the ball and the disk equally heavy? Do they weigh the same?

Why? ...........................................................................................................

Are you sure? ............................................................................................

**THIRD PART**

Examiner asks the child to transform the disk into a ball again and make the two balls exactly the same (size, shape and weight).

Agrees ( )

After the child has ascertained the equality of the two balls the examiner will proceed.

Suppose I divide this ball here in seven pieces, what will happen?

Will there be the same amount of clay in the ball as in the seven pieces?

Answer. ......................................................................................................

Why? ...........................................................................................................

Will the weight of the ball be the same as the weight of these seven pieces?

Answer. ......................................................................................................

Why? ...........................................................................................................

**Seven Pieces**

Examiner will ask the child to transform one of the balls into seven pieces. If child does not do it, the examiner will perform the
transformation in front of the child. The seven pieces are placed in a
sheet of paper to indicate the unity. The other ball will be placed in
another piece of paper.

1. **Conservation of Substance**

   Is there the same amount of clay in the ball as in the seven 
   pieces? What do you think?

   more in the ball () more in the pieces () same ()

   Why?.................................

   Are you sure?............................

2. **Conservation of Weight**

   Are the ball and the seven pieces equally heavy? Do they weigh the 
   same?

   more the ball () more the seven pieces () same ()

   Why?.................................

   Are you sure?............................
Research Instrument, Portuguese Version.

The following is the Portuguese version of the interview process which was used in this study:

Nome........................................... Sexo.................................
Idade.......................................... D. Nac............................
Grau.......................................... Data.................................

Identificação de Material

massa ( )  Argila ( )  não sabe ( )  outro ( )

Aceitação da Igualdade das Bolinha

Presenta-se ao sujeito 4 bolinhas iguais (tamanho, forma e peso), se pede ao sujeito para escolher 2 bolinhas, igualmente grandes e igualmente pesadas.
- Há a mesma quantidade de massa nessas duas bolinhas? São iguais?
  Aceita ( )

Si existe uma dúvida se pede que faça elas igualmente grandes e igualmente pesadas. Uma vez identificadas como iguais as duas bolinhas, se continua.

PRIMERA FASE

- Que se passara se eu transformo uma das bolinhas em uma salsicha?
- A bolinha o a salsicha possuirão ainda a mesma quantidade de matéria massa?
Reposta..........................................................
Porque?.........................................................
- A salsicha pesara o mesmo que a bolinha?

Reposta.................................................................

Porque?.................................................................

Forma de Salsicha.

O examinador pedera ao sujeito transformar uma das bolinhas em salsicha. Si o sujeito nao quer fazer a transformacao, entao o Examinador a fara diante do sujeito.

1. Conservacao de Substancia.

- Ha a mesma quantidade de massa em a bolinha e em a salsicha?
- O que voce pensa?
  mais na bolinha () mais na salsicha () Mesma ()
- Porque?.................................................................
- Voce tem certeza?....................................................

2. Conservacao de Peso.

- Sao, a bolinha e a salsicha, igualmente pesadas? Pesan elas o mesmo?
  mais a bolinha () mais a salsicha () mesmo ()
  Porque?.................................................................
  Voce tem certeza?....................................................

SEGUNDA FASE

O Examinador pede ao sujeito que transforme novamente a salsicha em
uma bolinha para que as duas fiquem iguais, igualmente grandes e igualmente pesadas.

aceita ()

Uma vez identificadas as duas bolinhas como iguais, se continua.

- Que se passara se eu transformo uma das bolinhas em um disco? A bolinha e o disco possuirão o terão ainda a mesma quantidade de massa, matéria?

Reposta.................................................................

Porque?.................................................................

- O disco pesará o mesmo que a bolinha?

Reposta.................................................................

Porque?.................................................................

Forma de Disco

O Examinador pedera ao sujeito transformar uma das bolinhas em disco. Se o sujeito não quer fazer a transformação então o Examinador a fara diante do sujeito.

1. Conservação de Substância

- Ha a mesma quantidade de massa em a bolinha e em o disco?

- O que você pensa?

mais na bolinha () mais no disco () mesmo ()

Porque?.................................................................

Você tem certeza?......................................................
2. **Conservação de Peso**

- São a bolinha e o disco igualmente pesados? Pesam o mesmo?
  mais a bolinha () mais o disco () mesmo ()

Porque?

Você tem certeza?

**TERCEIRA FASE**

O Examinador pede ao sujeito que transforme novamente o disco em uma bolinha, para que as duas fiquem iguais, igualmente grandes e igualmente pesadas.

aceita ()

Uma vez identificadas como iguais as bolinhas, se continua.

- Que se passara se eu transformo uma das bolinhas em sete pedacinhos? A bolinha e os pedacinhos possuirão ou terão ainda a mesma quantidade de massa, matéria?

Reposta.

Porque?

- A bolinha pesara o mesmo que os sete pedacinhos?

Reposta.

Porque?

**Secionamento (Sete pedacinhos)**

O Examinador pedirá ao sujeito transformar uma bolinha em sete pedacinhos, que são colocados em uma folha de papel para marcar bem a sua unidade total, a outra bolinha também se coloca em outra folha. Si
o sujeito não quer fazer a transformação, então o Eaminador a fara diante do sujeito.

1. **Conservação de Substância**
   - Ha a mesma quantidade de massa na bolinha e nos pedacinhos?
   - O que você pensa?
     - mais na bolinha () mais nos pedacinhos () mesma ()
     
     Porque?.................................................................
     
     Você tem certeza?......................................................

2. **Conservação de Peso**
   - São a bolinha e os sete pedacinhos igualmente pesados? Pesam o mesmo?
     - mais a bolinha () mais nos pedacinhos () mesmo ()
     
     Porque?.................................................................
     
     Você tem certeza?......................................................
Appendix B: Consent Forms, English and Portuguese Versions.

Principal
Scola Sant'Ana
Av. Dom Jose 980
62100 Sobral - Ceara
Brazil.

Dear Sister:

My name is Carmen Almandos, a doctoral student at the University of Massachusetts in Amherst (Bilingual/School Psychology Program).

In order to fulfill the requirements for the Ed.D. degree, I am conducting a study. The main purpose of this research is to determine how and when some students acquire the conservation concepts of substance and weight. The study, among other things, will help us to learn more about the cognitive development of certain students.

Children will be interviewed individually in the school for 30 to 45 minutes in a room separate from their regular classroom during school hours. Participation is voluntary. If a student expresses discomfort or does not want to answer the questions he/she can withdraw from the process.

Teachers will not have access to your child's protocol. However, the final results will be shared with the principal and according with the school's goals and needs, the results may be used for educational purposes in that particular setting.

If parents are interested, I could share with them the results of their own children. After the completion of the testing if any problems arise, parents can notify me within 15 working days, to withdraw the results of their child.

Thank you in advance for your cooperation.

Carmen Z. Almandos

I do understand and agree with the purpose of the study. I give my permission to Mrs. Carmen Z. Almandos to interview students in this school.

Principal's Signature
Prezada Freira:

Meu nome é Carmen Almandos, estudante do Programa de Doutorado (Bilingue-Psicologia Escolar), de Universidade de Massachusetts, Estados Unidos.

Para completar os requisitos do Programa de Doutorado, estou conduzindo uma pesquisa. O principal objetivo dessa pesquisa é determinar como e quando alguns estudantes adquirem o conceito de conservação de substância, peso e volume. O estudo, entre outras coisas, servirá para conhecer melhor o desenvolvimento cognitivo dos estudantes.

O aluno será entrevistado individualmente no colégio durante o horário de aulas por um período de 30 a 45 minutos. A participação é voluntária, se algum aluno achar incômodo as perguntas, não se continuará a entrevista.

Os professores não terão acesso aos resultados individuais dos alunos. No entanto, depois de conseguir os resultados gerais, serão apresentados a você para que, juntamente com os professores, os utilizem para propósitos práticos de ensino, de acordo com as necessidades e metas do colegio.

Fico muito grata pela colaboração e coloco-me à disposição de V. Sa.

Atenciosamente

Carmen Z. Almandos

Eu entendo e estou de acordo com o propósito do estudo. Dou permissão para que a Sra. Carmen Z. Almandos entreviste estudantes neste colégio.

Assinatura da Diretora
Dear Parent:

My name is Carmen Almandos, a doctoral student at the University of Massachusetts in Amherst (Bilingual/School Psychology Program).

In order to fulfill the requirements for the Ed.D. degree, I am conducting a study. The main purpose of this research is to determine how and when some students acquire the conservation concepts of substance and weight. The study, among other things, will help us to learn more about the cognitive development of certain students.

Children will be interviewed individually in the school for 30 to 45 minutes in a room separate from their regular classroom during school hours. Participation is voluntary. If a student expresses discomfort or does not want to answer the questions he/she can withdraw from the process.

Teachers will not have access to your child's protocol. However, the final results will be shared with the principal and according with the school's goals and needs, the results may be used for educational purposes in that particular setting.

If you are interested, I could share with you the results of your own child. After the completion of the testing if any problems arise, you can notify me within 15 working days, to withdraw the results of your child.

Thank you in advance for your cooperation.

Carmen Z. Almandos

I do understand and agree with the purpose of the study. I give my permission for my son/daughter to be interviewed.

Parent's Signature
Sr.

62100 Sobral Ceara
Brazil.

Prezados pais:

Meu nome e Carmen Almandos, estudante do Programa de Doutorado (Bilingue-Psicologia Escolar), de Universidade de Massachusetts, Estados Unidos.

Para completar os requisitos do Programa de Doutorado, estou conduzindo uma pesquisa. O principal objetivo dessa pesquisa é determinar como e quando alguns estudantes adquirem o conceito de conservação de substância, peso e volume. O estudo, entre outras coisas, servirá para conhecer melhor o desenvolvimento cognitivo dos estudantes.

O aluno será entrevistado individualmente no colégio durante o horário de aulas por um período de 30 a 45 minutos. A participação é voluntária, se algum aluno achar inconveniente as perguntas, não se continuará a entrevista.

Os professores não terão acesso aos resultados individuais dos alunos. No entanto, depois de conseguir os resultados gerais, serão apresentados a Diretora para que ela, juntamente com os professores, os utilizem para propósitos práticos de ensino, de acordo com as necessidades e metas do colégio.

Caso V. Sa. esteja interessado em conhecer os resultados do (a) seu (sua) filho (a), ou tenha alguma dúvida, por favor comunique-se comigo dentro o termo de 15 dias.

Fico muito grata pela colaboração e coloco-me à disposição de V. Sa.

Atenciosamente

Carmen Z. Almandos

Eu entendo e estou de acordo com o propósito do estudo. Dou permissão para que meu (minha) filho (a) seja entrevistado.

Assinatura do Pai/Mãe ou Responsável