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Validation of Conservation of Number, Length, Weight, Mass and Volume at the Concrete-Operational Stage of Piaget's Cognitive Development Theory in Mayo-Belwa Local Government Area, Adamawa State, Nigeria

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Abstract
The purpose of this study was to determine the extent to which children between the ages of 8-12 in Mayo-Belwa Local Government Area of Adamawa state exhibit the mental and behavioural characteristics of concrete-operational stages of Piaget's theory of mental development. A sample of 480 nursery and primary school pupils and unschooled children between the ages of 8-12 were selected using quota and purposive sampling techniques. One research question was formulated to determine the extent to which the mental and behavioural characteristics of 8-12 year old children in Mayo-Belwa Local Government area of Adamawa state conform to Piaget's theory on concrete-operational stage while the hypothesis determined whether sex influences children's attainment at concrete-operational stage of cognitive development. An instrument titled 'Piaget's Experimental Procedures and Interview Battery (PEPIB) was used to collect data. The instrument was subjected to face and content validation. The reliability index of 0.82 at the concrete-operational stage was obtained using Cronbach's alpha during the pilot study. During the main study, the Reliability value of 0.98 was obtained. These values were considered high enough to permit investigation. Descriptive statistics of frequency lines was used to answer the research question while a two sample Kolmogorov Smirnov test was used to test the hypotheses. The results of the findings revealed that children between the ages of 8-12 in Mayo-Belwa Local Government Area of Adamawa state exhibited all the mental and behavioural characteristics of concrete-operational stage of Piaget's cognitive theory, though with variations in the ages of attainment. The study found out that there were no significant differences in performance on conservation of number, mass, length, liquid, weight and volume between boys and girls at the concrete-operational stages of mental development It is therefore recommended that in using the theory, the age levels should not be taken as absolutes and that the theory can be used with confidence in non-western environments. Periodic training workshops should also be organized for elementary school teachers to understand how children think and learn.

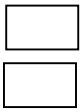
Keywords: Counselling and Human Development, Pre-operational, Concrete-operational, Conservation, Pre-operational thinkers, Concrete-operational thinkers

Introduction

The researcher's interest to carry out this study arose from involvement in the preparation for and supervision of teaching observation and practice-teaching of student-teachers in nursery and primary schools in Adamawa state's 21 Local Governments. It was while doing supervision of these student teachers that his interest on cognitive development was further kindled. Most of the students preferred to teach in the upper classes of the primary than to be posted to lower classes and nursery section. On being questioned for their preference, they explained that nursery school pupils and lower classes in the primary schools were difficult to teach mathematics because of their poor reasoning and intellectual growth. The researcher supervised a student-teacher in one of the rural schools in Mayo Belwa Local Government. The topic set for primary two pupils between the ages of 7-10 was simple addition and subtraction that required finding the missing link. The intellectual tasks were the following:

15 + ☐ = 30

10 - ☐ = 7



Despite the fact that these children know how to count, add and subtract simple numbers, a substantial number of them failed the problems including those that are big enough to be in the upper class of the primary school. It is assumed that the curricular content is based on the cognitive development of children at this level and considering the late entry of pupils to school in the local government, it is expected that the older pupils are supposed to do better than the young ones. The researcher therefore postulated that something was wrong with children's cognitive development.

It was at this time that the researcher's thought went to Piaget's theory of cognitive development who believes that cognitive development results from the interaction between a person and his physical and social environment. Most of the pupils that come to school do so around the ages of 8-10 when Piaget says that children are supposed to solve basic mental tasks such as Seriation, classification and conservation. If these children were able to conserve the basic properties of number such as addition and subtraction, they would not fail these sums particularly the older pupils. This therefore calls for the need to verify this theory among Nigerian children.

Piaget upholds that cognitive development results from an interaction between a subject and his/her total environment. This may therefore mean that a child who comes from impoverished environment would not be able to perform with success the basic intellectual task relevant to his/her chronological age as posited by Piaget. This may explain why children in Mayo Belwa do poorly in school work and this strengthens the assumptions that most Nigerian children may lag behind European children in performance on Piagetian tasks.

The works of Piaget (1962, 1969, and 1971), Piaget and Inhelder (1973) revealed that he conducted a longitudinal study on his three daughters, Lucienne, Laurent and Jacqueline and found that intellectual development is orderly and sequential and that a child's thinking is qualitatively different from that of adult. According to them, all children go through four main stages (sensori-motor, pre-operational, concrete-operational & formal operational) in the evolution of thinking ability which takes a number of years to develop. According to Piaget, children develop in sequence of stages by age from infancy to post adolescence. Each stage of learning is necessary for the development of the stage that follows. A child cannot skip a stage because each stage paves way for the one that follows.

The attention of the researcher was drawn to concrete-operational stage because of the mental and behavioural characteristics which are unique for other three stages (sensori-motor, pre-operational and formal-operational stages). The concrete operational stage is the third Piagetian stage of cognitive development which lasts from 8 to about 12 years of age. At this stage, children can perform mental operations which they could not do previously. However, such operations must be concretized. This is because they can only apply this new understanding to concrete objects which they have actually experienced. Imagined objects or those they neither have not seen, heard nor touched, continue to remain a mystery to them. The concrete operational child has developed the mental ability to perform all the tasks that the pre- operational child has failed to do. The stage is therefore characterized by performance of tasks that deals with conservation and reversibility

The law of reversibility states that every operation has a corresponding operation which is symmetrical to it and which helps one to return to one's starting point. It is therefore the ability of the child to perform reversible operations. Irreversibility which was the key principle of pre-operational stage, the child at this concrete-operational stage is able to perform reversible operations. He can mentally retrace his steps, cancel his actions and return to the original situation. As soon as this ability is developed, conservation ability sets in starting with conservation of number, substance, length, area, weight and volume. It should be noted that although the child at this stage is capable of logical thinking, this is limited to the manipulation of concrete objects and events. He cannot perform complex operations that involve the development of hypotheses until towards the end of this period which finally leads to formal operational stage.

Numerous conservation training studies have been carried out in both western and non-western environment to find out whether training would speed up conservation ability in children. The result

of these studies have been inconsistent, some reporting success and some reporting failure.(Murray,1976; Nyiti,1977;Philip and Kelly,1978;Fajemidagba,1983; Ebenebe,1986)

According to Thompson (1970), Durojaiye (1979) and Oladele (1987), Piaget did not use large samples to collect relevant data to back up his conclusions about the general pattern of mental development. His use of three children to conduct his longitudinal study sets the stage for further research. The three children were all females and it is known that sex differences lead to different performance on intellectual tasks. For instance, Ugwuegbu (1980) found out that girls excel in verbal tasks while boys excelled in spatial ability tasks. It is therefore obvious that the performance of western children may differ from those of Nigerian children. There is therefore the need for this study to examine sex differences in children's cognitive development

Variations in the ages of attainment of pre-operational and concrete-operational stages have been found by cross-cultural studies such as Abiola (1964, 65), Dasen (1973), Duruji (1980), Fajemidagba (1982), Bidell (1999), Heffner (2003), Gross (2005) and Edwards (2006). These studies reveal that while some children develop at the same rate with European children, others develop earlier than European children. In the light of these inconsistencies in research findings, this study saw the need to investigate the extent to which Nigerian children between the ages of 8-12 in Mayo-Belwa Local Government exhibit the mental and behavioural characteristics as posited by Piaget.

Piaget's theory of cognitive development was developed in western environment. The ideas of this theory are however holistically used to address problems in education in non-western environments without being aware of their limitations. In Mayo Belwa Local government Area, just like most parts of the states, the age of starting formal schooling is 6 years but a large proportion of children particularly in the rural areas start schooling at a much later age. It is therefore not uncommon to find children with age range of 6-11 years in primary one and two who find it difficult to read and write and perform simple numerical problems. This is contrary to Piagetian ideas that children who have attained the ages of 7-8 years should be able to perform classification and conservation tasks. Piaget's theory was developed using three children who were all female subjects. Cross-cultural studies have revealed differences in performance between male and female subjects. It is therefore possible that children's performance in western environment when compared with children of both sexes in non-western environment may differ. According to Piaget, cognitive development results from an interaction between a child and his total environment. Studies have shown that children in European environment actively interact more with their environment than children in non-western environment. Performance on Piagetian tasks may be expected to differ significantly between African and European children.

The ideas of Piaget's theory are mostly used in curriculum design and development and classroom teaching. However, problems arising from the use of the theory and how to promote cognitive development have not been considered by previous studies. Information is also lacking on how such problems can be addressed from the perspective of Counselling and Human Development Perspective.

Replication studies on Piaget's theory of mental development were concentrated in the period before independence. Since then, very few but isolated studies have been carried out in both western and non-western environments. It is therefore not conventional to use Piagetian ideas without first subjecting them to careful validation studies in order to update the results of previous studies so as to build more confidence in the use of the theory. As far as the search for literature is concerned, no replication study on Piaget's theory was carried out in Mayo-Belwa local government

The purpose of this study therefore is to verify whether the mental characteristics of concrete-operational stage of Piaget's theory are exhibited by children between the ages of 8 and 12 years in Mayo- Belwa Local Government Area of Adamawa State. Put in question form: To what extent will children between the ages of 8 and 12 years in Mayo- Belwa Local government Area exhibit the mental and behavioural characteristics of Piaget's concrete-operational stages of cognitive development? Can teachers, curriculum experts and other stake holders in the education industry use the ideas of the theory to handle educational problems in Nigerian schools?

Piaget did not use large samples to collect relevant data to back up his claims about the general pattern of mental development. The use of three children to conduct his longitudinal study sets the stage for further research. Will this study obtain similar findings using large samples? The three children were all females and it is known that sex differences lead to differences in performance on intellectual tasks. Will performance on Piagetian tasks between boys and girls differ significantly?

The objectives of the study are to determine:

1. the extent to which the mental and behavioual characteristics of Piaget's 8-12 year old children in Mayo-Belwa Local Government area of Adamawa state conform with Piaget's theory on concrete-operational stage.
2. whether sex influences children's attainment at concrete-operational stage of cognitive development

Research Question:

i. To what extent do the mental and behavioural characteristics of ages 8-12 in Mayo-Belwa local Government Area of Adamawa State conform to Piaget's theory on concrete-operational stage?

Hypothesis

H_{O1}: There is no significant difference between boys and girls in performance on Piagetian tasks at the concrete-operational stage of cognitive development

This study is limited to private nursery and public primary school children in Mayo- Belwa Local Government Area of Adamawa State. The study covers Nursery and Primary school children, schooled and unschooled children and children from Sangaya schools between the ages of 8 and12. The study is also limited to the study of the mental and behavioural characteristics such as conservation of number, length, weight, volume and substance at the concrete-operational stage of Piaget's theory of cognitive development.

A cursory look at the literature reviewed in this study shows that most of the works cited are outdated publications which however provides fertile grounds for further research. The use of some obsolete citations is therefore one of the limitations imposed on this research

Materials and Methods

The study utilized a descriptive survey design to collect data. According to Gay (1996), a survey design is an important attempt to collect data from members of the population in order to determine the current status of that population with respect to one or more variables. Survey research, according to Busha and Harter (1986) is characterized by the selection of random sample from a large and small population to obtain empirical knowledge of contemporary nature. This knowledge allows generalization to be made about characteristics, opinions, beliefs and attitude of the entire population being studied, Oche (2007) and Okoye (2003) see descriptive survey design as a research that involves direct contact with a population or sample that has similar characteristics which are relevant to specific investigation. The choice of this design was based on the fact that it enabled the researcher to determine the presence or absence of the attributes to be measured through interview and simple experiments. (Cross-cultural research design?)

This study was based on Simple experiments. Simple experiments were used in the past by Psychologists including Piaget in an attempt to study human behaviour. The survey design therefore used simple experiments and interview schedules to collect data from the target population. Like Piaget, a simple experimental set up such as a quite office in the school was used. The study involved carrying out experiments with the selected children using Piaget's simple experimental procedure The experimental apparatus were arranged on a large table according to the order of the tasks to be administered. Each variable to be tested has its own experimental procedures adapted from Piaget's work which was followed by the researcher in conducting the experiment.

Population and Sample

The population of this study consisted of all pupils between the ages of 8-12 in private nursery and primary schools, public primary schools and unschooled children in Mayo-Belwa local government Area. There are 125 public primary schools and 8 private nursery and primary schools with an estimated population of four thousand school pupils. Since simple experimental procedures were used to generate data, the researcher was not bound by the use of large samples in survey research. This is because conducting experimental

study is time consuming, which takes at least 30 minutes to treat a subject. A total of 480 subjects (240 boys, 240 girls) were drawn from private schools, urban (public), rural (public) and the unschooled. Ninety-six pupils for each age level were selected for the study from the four population segments. In order to ensure homogeneity and comparability among the data yielding subjects, equal number of subjects was maintained in the selection. A list of pupils between the ages of 8 and 12 years was taken from school records and used to carry out the experiments. The subjects were selected from the list using hat and draw method of random sampling

Research Instrument

The Instrument titled 'Piaget's Experimental Procedures and Interview Battery' **(PEPIB)** was developed by the researcher The researcher, during the process of reading and searching for relevant information, gathered and listed the characteristics of the pre-operational and concrete-operational stages of mental development from (Smith,1992, 96;Sternberg,1998;Presnel,1999;Bidell,1999;Santrock,2001;Gross,2005; Edarwds,2006). The studies of Piaget (1951, 52), Khan and Garrison (1973), Philip and Kelly (1978), Serafine (1988) and Santrock (2001) to mention a few, also provided information on the apparati and experimental procedures which were adapted for use.

This instrument is divided in to two parts: Part A which contains the experimental procedures used for the experiments has eight (8) sections. Each section contains simple experimental procedures which measures children's performance on a particular Piagetian attribute such as Classification and class inclusion ability, Serration, conservation of number, substance, length, liquid, weight and volume tasks.

Part B contains interview schedules for other Piagetian attributes that could not be measured using experimental procedures. The items were divided in to five sections: Animism, egocentrism, Barrage of questions, Right and left orientation and family orientation

The items were at this stage presented to specialists in instrument development. These are university lecturers in the area of Educational Psychology, Counselling and Educational Measurement. These Lecturers were requested via a letter to critically examine the relevance of the items in each section, the simplicity of expression, double barreled statements, clarity of items, statement of facts, vagueness of statements and any other relevant considerations to the instrument.

Based on the recommendations of the Validators, some items were deleted while others were re-arranged and a final instrument called '**'Piaget's Experimental Procedures and Interview Battery (PEPIB)** was developed. The researcher carried out a pilot study preliminary to the major study. It was carried out in Poli Academy, Kofare, in Yola South Local Government Area of Adamawa State

Reliability of the instrument

The measure of stability was obtained from a sample of 100 children (50 boys and 50 girls) who were not part of the target population. Cronbach's alpha was used to compute the reliability indices of the instrument. This yielded a coefficient of 0.71 for the pre-operational stage and 0.82 for the concrete-operational stage. During the main study, the following reliability values were also obtained: 0.73 for the Pre-operational stage and 0.89 for the concrete-operational stage. These values are considered high enough to conduct the study.

Procedure for data collection

The instrument was administered by the researcher to all subjects in each of the schools selected for the study. It was done individually in a quite office under permissive, game-like and untimed conditions. As the child entered the room, he or she was asked to supply information about him or herself such as name, age, class and date of birth. The aim was to confirm that the child's name was on the list of the pupils selected for the study

The tasks were administered in accordance with the instructions and order in which they were presented in the instrument. The experimental procedure which consists of probing the subjects' ability to perform through flexible interrogation was used. Questions and instructions were repeated where necessary. Each task began with an orientation session. The researcher recorded the subject's response and performance as he or she moved from one task to another

The duration of the interview was flexible which ranged between five to ten minutes. At the end of the experiments, the child was thanked and given

some sweets and asked to go back to the class. He or she was also given the name of the next child to call for the researcher. The researcher also reached out to unschooled children through Tsangya schools, Sunday schools and Christian Women's Fellowship meetings. This procedure applied only to this group of subjects. The names of the subjects were compiled according to age and sex.

Method of Data Analysis

The purpose of this study was to test the universality of Piaget's theory of cognitive development at the concrete-operational stage. The study south to determine whether or not children between the ages of 8 and 12 exhibit the mental and behavioral characteristics of Piaget's concrete-operational stage of mental development. The use of descriptive statistics such as frequency counts and percentages to answer the research question posed was therefore considered to be most appropriate. Hypotheses 1 was tested using a two-sample Kolmogorov Smirnov Test. Kolmogorov Smirnov test is a widely used non-parametric statistical test. It is concerned with the agreement between two sets of sample values of two cumulative distributions. If the two samples are drawn from the same populations, the cumulative frequency distributions of both samples are expected to be close to each other and the null hypotheses are expected to be accepted. If the deviation between the two sample cumulative distributions is large, the hypotheses are expected to be rejected. The use of this test is therefore most appropriate to this study because according to Oche (2007), it is more powerful than the Chi-square goodness of fit test because the numerical values are not affected by the size of the sample

Results

Research question 1: To what extent do the mental and behavioural characteristics of 8-12 year old children in Mayo-Belwa Local Government Area of Adamawa State conform to Piaget's theory on concrete –operational stage?

The results of the analysis are presented using frequency counts and percentages starting with conservation of number, mass, length, weight and volume etc. The results of the analysis are presented in Tables 1

Table 1: Conservation of Number by 8-12 year Old at the concrete-operational stage

Age	Conservers		Non-Conservers		
	Frequency	Percentage (%)	Frequency	Percentage (%)	**Total**
8	66	68.8	30	31.3	100
9	74	77.1	22	22.9	100
10	71	74.0	25	26.0	100
11	80	83.3	16	16.7	100
12	83	86.5	13	13.5	100
	374	100	106	100	

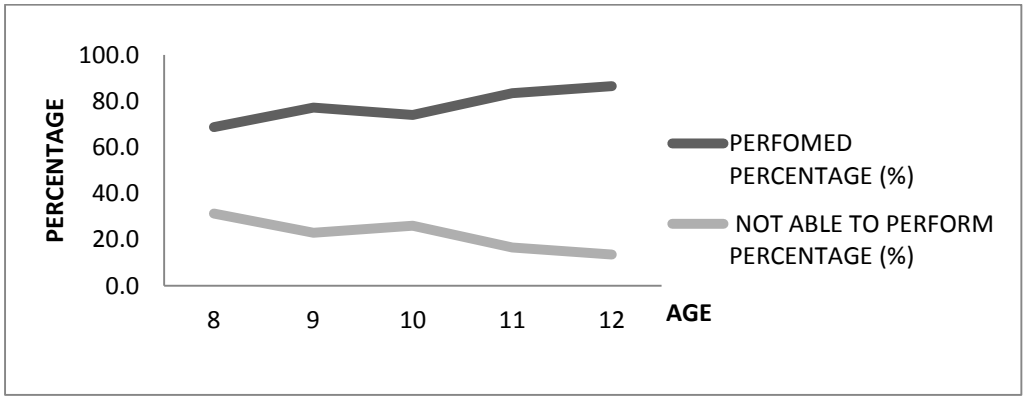


Table 1 shows the analysis of children's performance on conservation of number at the concrete-operational stage. The result of the analysis shows that 68.8% of the children at the age of 8 demonstrate the ability to conserve number and this ability increases as they grow older. According to

Piagetian theory, performance on conservation tasks is automatic once the child reaches a particular age level. However, this study has revealed that contrary to Piaget's views on mental development, some children still find it difficult to carry out this mental task with success. For instance, 31.3% of 8 year olds and 13.5% of 12 year-olds were not able to conserve number tasks. However, the number of non-conservers drops as the children grow older except at the age of 10 where 26 % of the children failed to conserve.

Table 2: Conservation of Mass by 8-12 year Old at the concrete-operational stage

Age	**Conservers**		**Non-Conservers**		
	Frequency	Percentage (%)	Frequency	Percentage (%)	**Total**
8	75	78.1	21	21.9	100
9	94	97.9	2	2.1	100
10	92	95.8	4	4.2	100
11	96	100.0	0	0.0	100
12	94	97.9	2	2.1	100
	451	100	29	100	

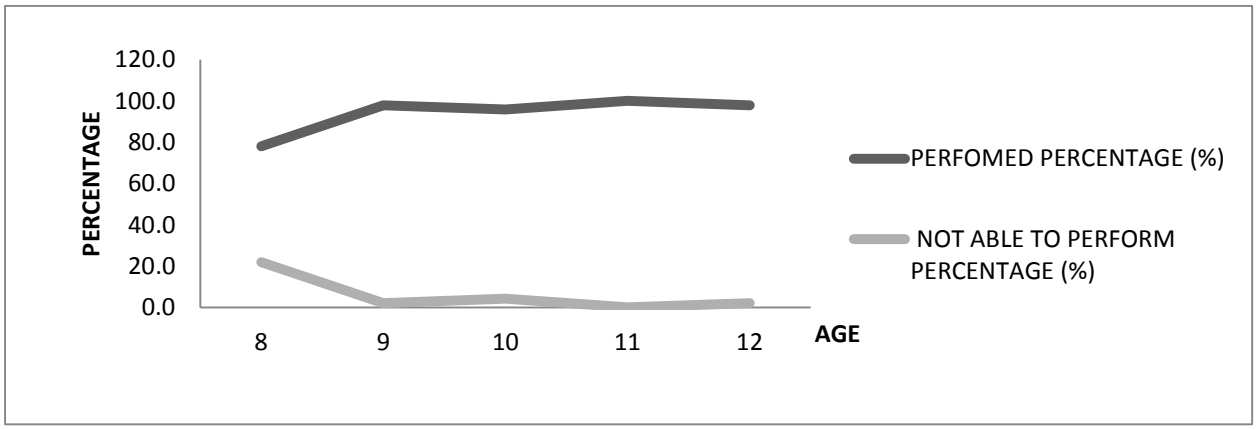


Figure 2: Percentage of Conservation of Mass at the Concrete operational stage

Table .2 shows the analysis of children's performance on conservation of mass at the concrete-operational stage of mental development. The result of the analysis showed that children at designated age levels were able to successfully conserve mass as posited by Piaget. However, a few of them found it difficult to do particularly at the age of 8 where about 21.9% of them could not conserve the tasks administered to them. This is contrary to Piaget's assumption that children who reach this stage should automatically conserve all mass tasks. Children's mental characteristics on conservation of mass conform to Piaget's theory on concrete-operational stage but with a slight variation in the ages of attainment.

Table 3: Conservation of Length by 8-12 year Old at the concrete-operational stage

Age	Conservers		Non-Conservers		
	Frequency	Percentage (%)	Frequency	Percentage (%)	**Total**
8	73	76.0	23	24.0	100
9	94	97.9	2	2.1	100
10	93	98.9	1	1.1	100
11	96	100.0	0	0.0	100
12	94	97.9	2	2.1	100
	450	100	28	100	

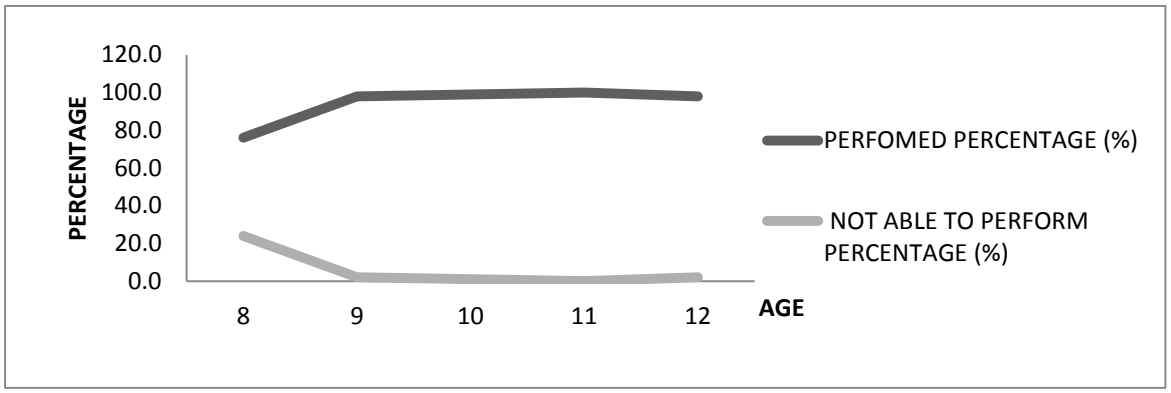


Figure 3: Percentage of Conservation of length at the Concrete operational stage

Table 3 shows the results analysis of children's performance on conservation of length at the concrete-operational stage. The analysis showed that a large proportion of children were able to conserve length and this number rose steadily with increasing age. On the other hand, the few children who could not conserve length decreased progressively with increasing age. According to Piaget's assumption, children at the concrete-operational stage have acquired mental abilities to enable them conserve length successfully. The result of the analysis is therefore in line with this assumption except a few at the age of 8 and 12 where 24% and 2.1% respectively could not observe length. This does not however invalidate the theory because Piaget's mental stages are not absolutes

Table 4: *Conservation of Liquid by 8-12 year Old at the concrete-operational stage*

Age	Conservers			Non-Conservers		
	Frequency	Percentage (%)		Frequency	Percentage (%)	**Total**
8	75	78.1	96	21	21.9	100
9	84	87.5	96	12	12.5	100
10	91	94.8	96	5	5.2	100
11	96	100.0	96	0	0.0	100
12	88	91.7	96	8	8.3	100
	434	100		46	100	

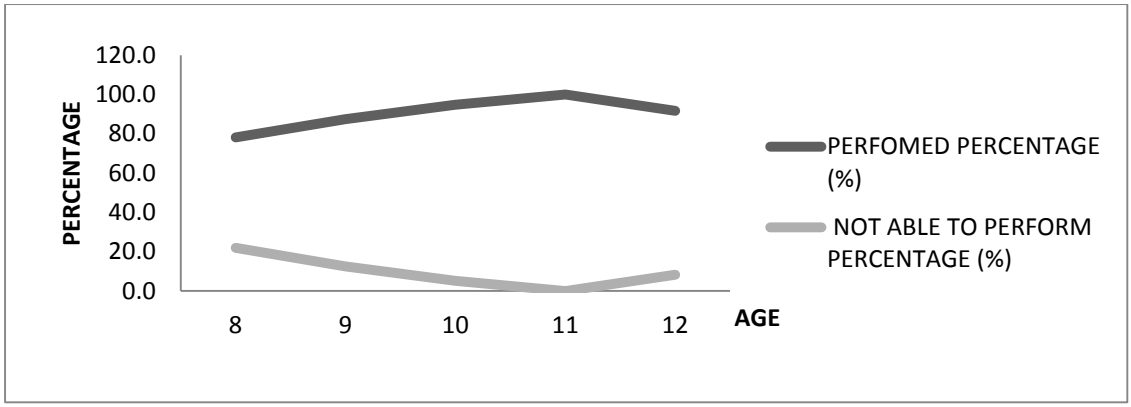


Figure 4: Percentage of Conservation of Liquid at the Concrete operational stage

Table 4 shows the results of analysis of children's ability to carry out conservation of liquid tasks at the concrete-operational stage. The table showed that the number of children that were able to conserve liquid rose steadily from8.1% to 100% at the age of 10. On the other hand, the proportion of those who could not conserve decreased progressively with increasing age The result therefore revealed children's ability to exhibit the mental characteristics as posited by Piaget though with variations in the age of attainment. For instance, contrary to Piaget's assumption 21.9% of 8 year olds could not conserve liquid. This inability however decreases as children grow older.

Table 5: Conservation of Weight by 8-12 year Old at the concrete-operational stage

Age	**Conservers**		**Non-Conservers**		
	Frequency	Percentage (%)	Frequency	Percentage (%)	**Total**
8	73	76.0	23	24.0	100
9	86	89.6	10	10.4	100
10	94	97.9	2	2.1	100
11	96	100.0	0	0.0	100
12	92	95.8	4	4.2	100
	441	100	39	100	

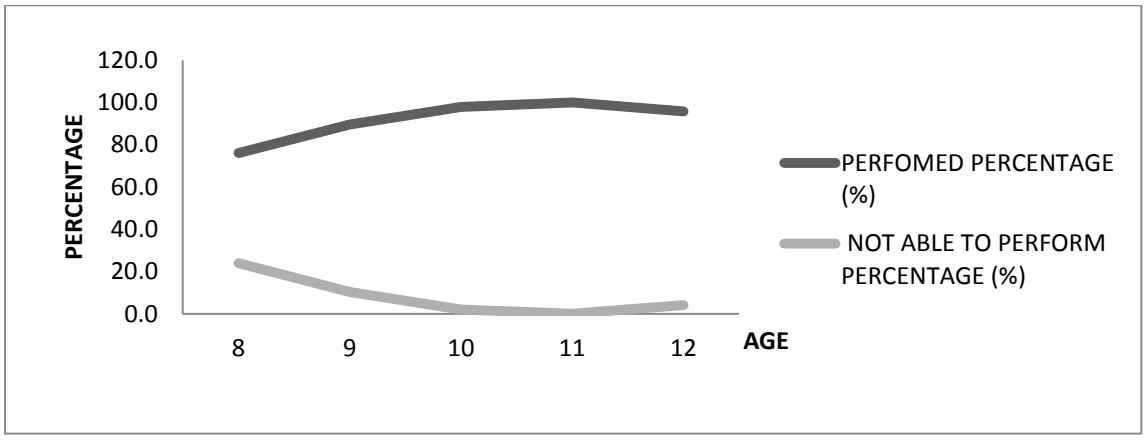


Figure 5: Percentage of Conservation of Weight at the Concrete operational stage

Table 5 shows the results of analysis of children's performance on conservation of weight at the concrete-operational stage. The result showed a steady increase in the ability to conserve weight except a few of them at the age of 8 and 9 where 24.0% and 10.4% respectively could not conserve liquid. This is contrary to Piaget's assumptions who postulated that children between the ages of 8-12 years at the concrete-operational stage have developed thinking abilities to be able to

successfully carryout conservation tasks. Children at this stage were able to conserve weight as posited by Piaget though with slight variation n the age of attainment

Table 6: Conservation of Volume by 8-12 year olds at the concrete-operational stage

Age	**Conservers**		**Non-Conservers**		
	Frequency	Percentage (%)	Frequency	Percentage (%)	**Total**
8	73	76.0	23	24.0	100
9	86	89.6	10	10.4	100
10	85	88.5	11	11.5	100
11	84	87.5	12	12.5	100
12	89	92.7	7	7.3	100
	417	100	63	100	

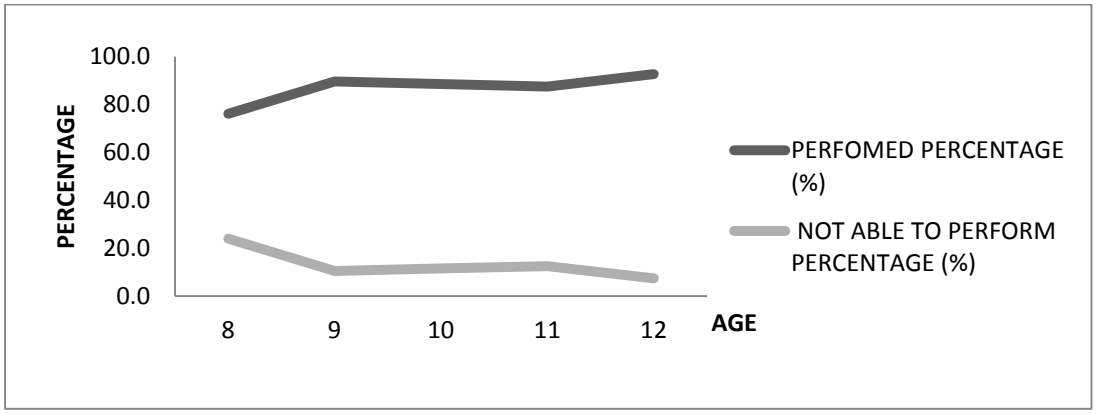


Figure 6: Percentage of Conservation of Volume at the Concrete operational stage

Table 6 shows children's ability to conserve volume at the designated ages. The result of this analysis showed that while there is a steady increase in children's ability to conserve with increasing age, those who could not conserve, decreased progressively with increasing age. Piaget posits that 8-12 year old should be able to carry out mental tasks successfully but from this study, there were few non-conservers.

Hypothesis 1: There is no significant difference between boys and girls in performance on Piagetian tasks at the concrete-operational stage of cognitive development.

The hypothesis sought to determine whether sex differences has any effect on children's ability to carry out conservation of number, mass, length, liquid and volume at the concrete-operational stage. The results of the analysis to test the hypothesis are presented according to mental characteristics:

Table 7: K-S analysis of performance between boys and girls on conservation of number tasks at the concrete-operational stage

Age	8	9	10	11	12	N
Cum. F (Boys)	39/198	81/198	118/198	158/198	198/198	383
Cum % (Boys)	0.19	0.41	0.59	0.02	1.0	
Cum. F (Girls)	31/185	61/185	103/185	143/185	185/185	
Cum % (Girls)	0.17	0.33	0.56	0.77	1.0	
d -	0.02	0.08	0.03	-0.75	0	

K-S Z value: 0.08 Sig. Level : 0.14 Decision: Not Significant

In Table 7, it is evident that the K-S Z value (0.08) is less than the critical value of 0.14 at 0.05 alpha level of significance. The null hypothesis is therefore accepted and conclusion drawn that a significant difference does not exist between boys and girls on conservation of number tasks at the concrete-operational stage.

Table 8: K-S analysis of performance between boys and girls on conservation of mass tasks at the concrete-operational stage

Age	8	9	10	11	12	N
Cum. F (Boys)	31/175	70/175	109/175	142/175	175/175	347
Cum % (Boys)	0.17	0.4	0.62	0.81	1.0	
Cum. F (Girls)	18/172	58/172	89/172	128/172	172/172	
Cum % (Girls)	0.1	0.33	0.52	0.74	1.0	
d -	0.07	0.07	0.1	0.07	0	

K-S Z value 0.07 Sig. Level 0.15 Decision: Not significant

Analysis of data on Table 8 shows that the K-S value (0.07) is less than the significant value of 0.15 at P<0.05). The null hypothesis is therefore accepted which means that there is no significant difference in performance between boys and girls on conservation of mass at the concrete-operational level.

Table 9: K-S analysis of performance between boys and girls on conservation of length at the concrete-operational stage

Age	8	9	10	11	12	N
Cum. F (Boys)	44/200	73/200	121/200	160/200	200/200	401
Cum % (Boys)	0.22	0.36	0.61	0.8	1.0	
Cum. F (Girls)	33/201	78/201	117/201	159/201	201/201	
Cum % (Girls)	0.16	0.37	0.58	0.79	1.0	
d -	0.06	-0.01	0.03	0.01	0	

K-S Z Value: 0.06 Sig. Level: 0.14 Decision: Not Significant P>0.05

Table 9 shows the Kolmogorov Z is 0.06 while the significant value is 0. 14 at 0.05 alpha level of significance. The null hypothesis is accepted which states that there is no significant difference in performance in favour of boys on conservation of length at the concrete-operational stage.

Table 10: K-S analysis of performance between boys and girls on conservation of length at the concrete-operational stage

Age	8	9	10	11	12	N
Cum. F (Boys)	36/185	65/185	103/185	143/185	185/185	354
Cum % (Boys)	0.19	0.35	0.56	0.77	1.0	
Cum. F (Girls)	31/169	59/169	95/169	129/169	169/169	
Cum % (Girls)	0.18	0.35	0.56	0.76	1.0	
d -	**0.01**	0	0	0.01	0	

K-S Z Valu : 0.01 Sig. Level : 0.14 Decision: Not Significant

results of data analysis on Table 10 show that the K-S Z value (0.01) is less than significant value (0.14) at P<0.05. The null hypothesis is therefore upheld which states that there is no significant difference in performance on conservation of liquid between boys and girls at the concrete-operational stage.

Table 11: K-S analysis of performance between boys and girls on conservation of liquid at the concrete-operational stage

Age	8	9	10	11	12	N
Cum. F (Boys)	31/175	63/175	97/175	135/175	175/175	357
Cum % (Boys)	0.17	0.36	0.55	0.77	1.0	
Cum. F (Girls)	31/182	68/182	106/182	146/182	182/182	
Cum % (Girls)	0.17	0.37	0.58	0.80	1.0	
d -	0	-0.01	-0.03	-0.03	0	

K-S Z Value : -0.03 Sig. Level : 0.14 Decision: Not Significant. P>0.05

The result of the data analysis is presented on Table 11 which shows that the observed Kolmogorov Z value of -0.03 is less than the significant value of 0.14 at 0.05 level of significance. The null hypothesis of no significant difference is accepted which states that there is no significant difference in performance between boys and girls on conservation of weight at the concrete-operational stage.

Table12: K-S analysis of performance between boys and girls on conservation of weight at the concrete-operational stage

Age	8	9	10	11	12	N
Cum. F (Boys)	35/168	73/168	98/168	130/168	168/168	332
Cum % (Boys)	0.21	0.43	0.58	0.77	1.0	
Cum. F (Girls)	26/164	52/164	85/164	121/164	164/164	
Cum % (Girls)	0.16	0.32	0.52	0.73	1.0	
d-	0.05	0.11	0.06	0.04	0	

K- S Z Value : 0.11 Sig. Level : 0.15 Decision: Not Significant.

Table 12 indicates that the Kolmogorov Z value of 0.11 is less than the significant value of 0.15 at 0.05 level of significance. The null hypothesis is upheld implying that a significant difference does not exist in performance between boys and girls on conservation of weight at the concrete-operational stage.

Discussion

The findings of research question one revealed that children between the ages of 8-12 years in Mayo-belwa local government area exhibited the mental and behavioural characteristics at the concrete-operational stages as postulated by Piaget's theory of mental development though with variations in the ages of attainment. The researcher conducted a

comparative study of performance on conservation tasks between pre-operational and concrete-operational thinkers in order to determine the extent to which they differ on conservation abilities. Conservation of number was the first attribute that was experimented. The aim was to determine whether children's visual impression of the length of the row of chewing gum overrides the numerical equality of the objects or they consider numerical equality more important than visual impressions. The researcher, using the recommendations of previous studies on the use of familiar materials, made use of stimulus materials (Apple Chewing Gum) to conduct the experiment on the conservation of number. This enhanced the performance of testees considering the level of interest shown during experimentation. The testees were told that they will be given part of the chewing gum after the experiment. When pieces of chewing gum were presented, greater attention was paid and this lead to the subjects' demonstration of the skills they had. The result of the experiment showed that contrary to Piaget's (Piaget, 1971) assumption that conservation ability begins from the ages of seven or eight, some pre-operational thinkers were able to conserve number while some at the concrete-operational did not. Non- conservers at the pre-operational stage argue that pieces of chewing gum which are spread out are more in number than the same number of chewing gum that are put close together in a row. These children had earlier confirmed the equality of number of the chewing gum. The children think that the equality of the sets is disrupted by their spatial arrangement. The finding of this study agree with the work of Bidell (1999), Santrock (2001) and Morra (2003) who, together with their colleagues investigated the conservation of number among kindergarten pupils. In their study, two groups of objects were arranged in front of a child in parallel row in such a way their numerical equality was clear. One of the rows was re-arranged and the child's awareness of the persistence of numerical equality was assessed. The children insisted that the longer row contains more objects than the clustered objects. At this stage, the impression of length overrides the numerical equality of number. The qualitative interrogations have also been confirmed by Piaget & Inhelder (1969)

The experiment the researcher conducted on conservation of substance (mass) was very exciting. The descriptive analysis of children's performance on conservation of mass at the concrete-operational stages showed that some concrete-operational thinkers were found to operate at the pre-operational stage. There was clear evidence that the thinking of non-conservers was dominated by perceptual centering. Children could centre but could not decenter. They focused their thought on single dimension at the neglect of others. Most of the children argued during experimentation that the amount of clay was more because it was longer. Others did not give a reason to justify their answer.

Most of the children between the ages of 10 and 12 conserved mass because they gave satisfactory answers showing evidence of conservation. Examples of statement made are: "all of them are the same; as they were the same before'. A few of them say that their ball of clay has only undergone a change of shape. The conclusion of this experiment lend credence to the work of Piaget (1952) who theorized that children between the ages of 8-12 are able to centre and decentre because they consider all aspects of the problem in an attempt to solve them. The result of this experiment is backed by other studies and cross-cultural researchers such as Ogilvie and Lovell (1960), Otalla (1973), Durojaiye (1979), Santrock (2001) etc.

Experiments on conservation of length were also carried out to determine the extent to which children could conserve equality or inequality of length. From the experiments conducted, most of the children at the concrete-operational stage conserved length, but a few did not. When the researcher placed two pencil Candies or two identical sticks evenly side by side, children correctly judged that the sticks were the same length. However, when one of the sticks was moved slightly to the right of the other, some children under the age of 7 thought that the moved stick was longer than the unmoved one. Furthermore, when presented with a stick and a sinuous one equal in length with the same end points, many of them could not identify the illusion and argued that they were the same. Most of the testees between the ages of 8-12 saw the illusion and confirmed that the sinuous stick was longer than the straight stick though the end points were the same. Asked why, they confirmed that if the sinuous stick was stretched, it would be longer.

The behaviours exhibited by these children during experimentation are very similar to the ones obtained by Piaget (1969; 1971). However, performance of these children on this experiment did

not agree with the findings of Murray (1976) Piaget, Inhelder and Steminka (1960) who reported that children under the age of 8 would not conserve length. This study found out those children at the age of 3-7 conserved length including illusion producing lines.

The results of the experiments on conservation of liquid tasks showed that some children at the pre-operational stage successfully conserved liquid while a few at the concrete-operational stage could not, contrary to Piagetian assumptions. During experimentation, many of them at the concrete-operational stage agreed that the amount of water in the bigger container is equal to the mount in the thin tumbler in spite of the great perceptual differences in the shape of the container." It is not the same because the container is bigger and insists that the amount of water in the tall thin glass is more than the water in the wider container even when the water was poured into it in the full view of the child. According to 4-6 year olds, the water in B is higher than it was in A and this means that it has increased in quantity regardless of the fact that it is the same water that has merely been poured from one container to another. The child does not believe that changes in the physical appearance of the container do not affect the quantity. This finding corroborated the studies of Piagetian & Ihelder (1969, 1973). Older children at the concrete-operational stage believe that 'it is the same water', nothing has been added or taken away, you can put the water in B back into A where it was before".

When the researcher raised one of the thin glasses with the help of a book, children respond that the two glasses do not have the same amount of water. They believe that the taller glass has more water. The results of this study have confirmed, though with variation at the age of attainment that the mental characteristics at this age are similar to the ones described by Piaget. It has also supported the work of Serafine (1988) whose study concluded that perceptual centration is very strong even in a task involving a one dimensional change. Other studies such as Gross (2005), Colson (2006), Edwards (2006) and Ogbebor (2006) have also confirmed that pre-operational children have the tendency to focus on only one aspect of the problem while those in the concrete-operational stage consider many aspects of the problem or situation at the same time. They understand that a tall slender container can hold the same amount of water as a short broad one.

The analysis of data on conservation of weight revealed early and late conservers at the pre-operational and concrete-operational stages. Most children gave many of the same kind of responses as the conservers in Piaget's sample and other replication studies. The older children gave more reasons for a judgment than younger children. For most non-conservers, weight is related to the degree of fitness or thinness. However, conservers reject this view that fatness or thinness of substance does not affect weight. Those children who are in the stage of concrete-operational stage that could not conserve weight are due to arrest (fixation) in the acquisition of experience in the physical world (Ogilvie & Lovell, 1960). The results of this experiment therefore are in line with the study of (Hooper, 1965; Ogilvie & Lovel, 1960; Bidell (1999) who reported that cultural differences and learning could lead to differences in performance. The results of the experiment on conservation of volume tasks identified early and late conservers at the pre-operational and concrete-operational stages respectively. During experimentation, the researcher poured water into two beakers A and B under the full view of the child. When a stone was dropped into one of the containers, non-conservers admitted more water is contained in the container with the raised water level. Non-conservers consider only the height of water level in the container while ignoring the stone that increased the water level. The result of the experiment confirmed the findings of Durojaiye (1979), Serafine (1988) and King (1960).

The hypothesis postulated tried to find out if there was any gender difference in performance on Piagetian tasks administered. The result showed that boys and girls did not differ significantly in performance on conservation of number, mass, length, weight, and volume at the pre-operational and concrete-operational stages of cognitive development. This finding is not in agreement with the studies of Bomide (1986), Nkpone (2001) and Okafor (2001) who reported sex differences in performance on intellectual tasks.

Conclusion

Based on the findings of this study, it was concluded that children between the ages of 8-12 in Mayo-Belwa Local Government Area of Adamawa State exhibited all the mental and behavioural characteristics of concrete-operational stage of Piaget's theory of mental development but with variations in the ages of attainment. According to

Piaget, children's performance on each Piagetian task is automatic. Once a child reaches a particular age, he is able to carry out successfully all the tasks designated for that stage. Contrary to this supposition, this study found that while some children across the age levels performed Piagetian tasks earlier than the designated stage; others performed the tasks at later stages. Piaget's stage theory therefore is not absolute in our school and cultural environment. There are bound to be variations in the ages of attainment.

The study did not find any significant difference in performance on conservations of number, mass, length, liquid, weight and volume between boys and girls. This study corroborates Piaget's theory of mental development who did not consider sex as important determinant for performance on mental tasks. This has therefore strengthened the universality in the use of the theory.

Recommendations

Consequent upon the findings and discussions of results, the following recommendations are made for the improvement of children's academic and social wellbeing:

1. The study found out that children between the ages of 8-12 years exhibited all the mental characteristics as posited by Piaget though with variations in the ages of attainment. It is therefore recommended that in using the theory, the age levels should not be taken as absolutes
2. The study did not find any significant difference in performance on Piagetian tasks between boys and girls. It was therefore recommended that teachers should treat all learners particularly those who are not doing well in school subjects with empathy. They should know that all human beings are born with potentials to be developed but environmental factors such as diseases, poor nutrition and language lead to poor growth and development which restrict the acquisition of relevant experience that are necessary for the process of assimilation and accommodation which are critical in the development of intelligence.

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