ASSESSMENT OF EARLY MATHEMATICS ABILITY OF LOWER BASIC EDUCATION PUPILS. PRACTICAL USE OF THE PIAGETIAN TESTS.

by

Obienyem, C, Obienyem, B.I.&Okolo,Emmanuel.

F.C.E(T),UMUNZE. drobienyemchike@gmail.com

Abstract

This study investigated Early Mathematics Ability of Lower Basic Education pupils in Aguata Education Zone of Anambra State. It is quasi experimental and involved a sample of fifty - six (56) primary one pupils selected through a multiple random sampling techniques in their intact classes. The instrument for data collection is a 9-item cognitive test developed in line with Piagets test guide in the area of conservation of numbers, length, continuous quantity and weight of objects. It was validated by two experts in Mathematics education. Findings showed that the primary one pupil (5-6) years used in the study tend to be confused when the relative position of objects was changed. Significant proportion of the pupils could not recognize that changes in the shape of identical objects did not affect the weight and quantity of the substance. The researchers recommended that teachers should involve the pupils effectively through exploratory and experimental teaching activities making good use of teaching materials etc.

Introduction

The attention given to mathematics in the school curriculum speaks loud of its importance in every aspect of human life. It is a service discipline, language for expressing the contents of other subjects in a better and comprehensible form. It suggests that learners be adequately and timely equipped with the basics of the discipline. Unfortunately this is not so as teaching and learning of Mathematics at this level is not encouraging. Clement (2014) observed that

a number of school children enter college unprepared. This author suggested that ungraded pretest and interest inventories can be used to see what the students already know about the content of the instruction.

In view of the above Ma (1999) investigated into reasons for differences in the mathematical achievement of children in the United States and children in higher- performing countries, and states that fundamental, or elementary, Mathematics is a deep, complicated subject that requires thorough study in order to comprehend and teach. This author argued that teachers must possess profound knowledge of fundamental Mathematics. In a similar situation, McAleavy (2012) while exploring the pupil led-led aid research lesson approaches used in some countries observed thus, as a nation we underperform in Mathematics. To improve, we have to start from the basic at primary level. There is no doubt that most experiences in educational failures is associated with poor Mathematical foundation.

Through effective use by or adaptation of standardized tests, the Mathematics ability level of the pupils needs to be determined so that the curriculum can be effectively and efficiently presented to the learners. The results of such early assessments will reveal the extent of Mathematics readiness of the pupils in agreement or otherwise with the intention of such assessment tools. The results will enable the implementers of the curriculum design appropriate remediation that can address adequately the expected previous learning experiences desired for effective take off of the lower basic primary education. There is no doubt that the establishment of the Mathematics ability of the pupils will give focus and meaning to effective teaching of Mathematics content at this level.

The national policy on education (FRN, 2013) expressed the importance of this level of education to the entire system of education in the country. The lower basic primary education lasts for a period of three years and Mathematics is one of the subjects offered at this level. Some of the objectives of primary education include this two among others:

1) inculcation of permanent literacy , numeracy and the ability to communicate effectively;
2) Laying of a sound basis for scientific, critical and reflective thinking etc.

The document recommended that teaching at this level shall be participatory, exploratory, experimental and child-centered. Analysis of the objectives suggests that the child must be adequately equipped to participate effectively in any Mathematics activity in the classroom setting. To achieve this, Wolk (2001) emphasized:

> *That the teacher must be passionate about learning and should be able to create an infectious classroom environment. This type of environment allows children time to learn. The teacher will be in a better position to employ a particular learner-centered method suitable to a particular child or group of learners.*

Ginsburg and Baroody (1990) developed a 65-item test from informal and formal mathematics for establishing early mathematics ability of pupils between the ages of (3 – 8) years. It is untimed, but lasts between (5 – 15) minutes to administer. (Satler, 2001, p 606). Piaget (n.d) developed a number of tests for establishing early Mathematics ability level of children between ages of 5 – 11 years. It covered such areas as:

1) The understanding of conservation.
2) logical operations
3) seriation.Conservation is broken into conservation of number, continuous quantity (solids), length and weight.

It measures the child's ability to demonstrate understanding that variations or modes of configuration of a row of objects do not change the number of the objects or situations. Tasks on conservation of continuous quantity (solids) measure the learner's ability to demonstrate understanding that changes in the shape of the solid, does not affect the quantity of the substance. Also conservation of length measures the learner's ability to demonstrate understanding that comparative lengths of objects are not affected by their relative positions. Those on weight measure the ability of the individual to demonstrate understanding that changes in the shapes of objects do not cause changes in the weight of the objects.

To refocus Mathematics teaching and learning in schools especially at the lower basic primary to encourage a participatory, exploratory, experimental and child-centered learning environment, the researchers set out to find out the extent to which Piagets' Mathematics ability tests still apply to learners within the age group (5-11) years especially in this period of great ICT awareness, improvement in child healthcare development and enhanced living environment.

Purpose of the study

Sattler (2001) observed that Piaget's theory provided insight into child's thinking process. The study assessed early mathematics ability of lower basic primary school pupils. Specifically it set out to:

1. Determine the extent primary one pupils demonstrate understanding for the conservation of number, continuous quantity (solids), length and weight.

Research Question

Two research questions were used.

1. What percentage of the pupils used demonstrated good ability in the understanding of conservation in the areas covered in this study?
2. Which of the areas do the pupils show outstanding performance?

Hypothesis: One hypothesis was used in the study.

There is no significant difference between the observed response frequencies of the respondents on their ability to show conservation of number, length, quantity of continuous solids and weight.

Research procedure/treatment

The study is a survey and involved 56 primary one pupils used in their intact classes in Aguata Education Zone of Anambra state. The research method adopted was such that the pupils were given opportunity to explore their environment in order for learning to occur in line with constructionist theory of learning. Sample is made up of five intact classes from five selected schools in the zone. Multiple random sampling techniques were used. Researcher developed test items in line with the guideline in the Piagets' sample test was used for data collection. (Sattler 2001, p562).9-items which required the subjects manipulating objects and substances including rearrangement in order to respond to the questions were used. The instrument was validated by two experts in Mathematics education.

The instrument and materials administered provided opportunity for the pupils to participate effectively by touching, arranging and observing clearly the experimental treatments by the research assistants. Simple percentage was used to provide answer to the research questions while the Chi –Square was employed for test of the hypothesis.

Classroom Setting:

Activities were preplanned and were covered in a normal lesson period (35) minutes.

Stage one: (conservation of number).

Treatment A: Two rows of objects having the same size, different in colours but equal in number were presented in one – to – one correspondence in a horizontal mode on a table. The children were to say if the items are the same in number. The teacher led the pupils to understand that the rows have the same number of items.

Treatment B: The two rows of items were then re-arranged vertically with wider space between the items. They still maintained one-to-one correspondence. Change in configuration was tested if it influenced the ability of the pupils in recognizing that the numbers of the items was not affected by their mode of arrangement.

Stage two: Conservation of continuous quantity (solids)

Treatment A: Two balls of clay identical in size, shape and weight were presented. They were led with questions to understand that the balls have the same quantity of clay.

Treatment B: One of the balls was remolding into a cylindrical shape. The pupils were then asked to say which of the shapes has more quantity of clay.

CONSERVATION OF LENGTH

*Treatment A***:** Two unsharpened pencils, identical in length and colour were presented before the pupils. The pencils were laid horizontally on the table about 2cm apart. The children were led to understand that they are equal in length.

Treatment B: The two pencils were re-arranged and rotated about 45^o in the clockwise direction while parallel to each. They were then required to find out if the *pencils* were still the same in length.

CONSERVATION OF WEIGHT

Treatment A: Two balls of clay identical in size, shape and weight were presented before the children. They were led to understand that the two balls have the same weight.

Treatment B: The pupils watched the teacher squeeze one of the balls and mold the clay into a saucer. They were then required to say if the ball and the saucer have the same weight.

Treatment Control: At the end, of each treatment and test, the pupils' responses were collected from them before the next stage of the experiment to control for copying from one another.

Presentation and Analysis of results

Question one:

What percentage of the pupils used demonstrated reasonable ability for conservation of the concepts?

Table I: Summary of response on pupils ability to conserve number property.

S/N	ITEMS	NO	%	YES	%	NO IDEA	%
1.	Are the shapes as arranged equal in number?	12	22.2	37	65.3	7	12.5
2.	Are the shapes as arranged equal in number?	5	9.7	47	84.7	4	5.6
3.	What is the number in each line?	0	0	47	84.7	9	15.3

From table one above, when the twenty identical items with ten in each group were arranged horizontally on the table, the pupils were required to identify if the quantities are the same in number. From item one, 37 pupils recognized the items as the same in number. This represents 65.3%. 12 of the pupils did not see the arrangement to have the same number of items. (22.2%) while 7 (12.5%) had no idea of what to say. The result shows that mode of presentation of learning tasks can affect conservation ability in the children.

From item 2, the pupils were required to say the number in each, 47 (84.7) of the pupils gave the correct response while 5 (9.7) said no idea. When the shapes were rearranged in a slanting order but parallel to each other and in one-to –one correspondence, 47 (84.7%) were able to see that the shapes are still equal in number. 5 (9.7%) said they are not sure of what to say. Item 4 again required them to say the number in each line, 47 (84.7%) were able to do this while 9 (15.3%) had no idea.

Table 2: Conservation of continuous quantity (solids)

S/No	Items	Yes	%	No	%	No idea	%
4.	Do the shapes have the same quantity of clay?	33	59.7	13	23.6	10	6.7
5.	Which of the shapes has more quantity of clay	Cylinder 13	23.1	Ball 11	19.5	No idea 32	57.4

Two balls identical in size, shape and weight were presented. One of them was then squeezed and molded into a cylinder. They were then required to say if the shapes have the same quantity of clay.

From item 4, 33 (59.7%) identified the shapes to have the same quantity of clay. 13 (23.6%) said no while 10 (6.7%) said no idea. However, more than 50% of the pupils demonstrated reasonable ability to conserve continuous quantity. When the pupils were required to say which of the shapes (cylinder or ball) has more quantity of clay. 13 (23.1%) said it is cylinder while 11 (19.5%) said it is ball while 32 (57.4%) said no idea. This suggests that pupils' ability to conserve continuous quantity can be influenced by change in the shape of the substance. The pupils were not stable in their responses.

Table 3: Data on conservation of length.

S/no	Items	Pencils A	%	No idea	%	Same length	%
6.	Which of the pencils is longer	35	62.5	20	36.1	1	1.4

From table 3, after the pupils were led to understand that the two identical pencils used are equal in length, the two pencils were placed with more space between them in a slanting order, 35 (62.5%) of the pupils could not see the pencils to be equal again, 20 (36.1%) said they have no idea which is longer. Only 1 (1.4%) pupils said that the change in the relative position of the pencils did not change their lengths.

Table 4: Data on conservation of weight

S/No	Items	Same weight	%	Ball is heavier	%	Saucer is heaver	%
7.	Which of the shapes is heavier	13	23.6	36	63.9	7	13.1

For the conservation of weight, the pupils were led to understand that the identical balls are equal in weight. One was then squeezed and remolded into a saucer. They were then required to identify which is heavier.

From the table, 13 (23.6%) of the pupils identified the shapes to have the same weight, 36 (63.9%) said that ball is heavier than the new shape of saucer, while 7 (13.1%) said that saucer is heavier than ball. Question nine required the pupils to give reasons for their responses. 36 (63.9%) said that ball is taller than saucer and heavier while 20 (36.1) said that ball is not heavier than the saucer. For question ten, 7 (12.5) said that saucer is heavier because it can contain the ball and 49 (87.5%) said that saucer is not heavier.

Hypothesis: there are no significant differences between the observed and the expected frequencies on the data on ability of the pupils to conservation of numbers.

Table 5 : summary of Chi-Square analysis of subject's responses on conservation ability of number concepts and mode of arrangement.

S/no	Items	Failed	Right	No idea	Total	Chi-Square (cal)	Chi-Square tab.
1	What is the number of the shapes as arranged ?	12(4.5)	37 (45.50)	7 (6)	56	82.97	12.592
2	What is the number in each line?	0 (4.5)	47 (45.5)	9(6)	56		

(Expected frequencies are in the brackets)

$$X^2 = 82.97$$

$$df = 6.$$

The Chi-Square calculated is 82.97 while the tabulated is 12.592 at degree of freedom 6, level of significance 0.05, the null hypothesis was rejected. This implies that the observed response frequencies significantly differed from the expected. This suggests that greater number of the pupils demonstrated ability to conserve number even when the configuration was altered. The observed frequencies were a true representation of their cognitive developmental level. This agrees with the Piaget theory that children within the age level of (5 – 6) years begin to show ability to recognize number arrangement and modes of presentation.

Table 6 :summary of Chi-Square analysis of responses on conservation of quantity.

S/no	Items	Failed	Right	No idea	Total	Chi-Square (cal)	Chi-Square tab.
4.	Do the shapes have the same (amount) quantity of clay?	13 (12.1)	33 (23.2)	10 (20.7)	56	84.18	5.991
5.	Which of the shapes has more (amount) quantity of clay	11 (12)	13 (23.2)	32 (20.7)	56		

The Chi-Square calculated is 84.18 which is greater than the critical Chi-Square of 5.991 at 2 df and significant level 0.05, the null hypothesis was rejected. The observed response frequencies differed significantly from the expected frequencies. Higher percentage of the pupils demonstrated ability to conserve continuous quantity (solids), however when the pupils were asked which of the shapes ball or cylinder has more quantity of the substance, greater percentage became confused and responded no idea.

Table 7 : summary of Chi-Square analysis of responses on conservation of length.

S/no	Items	Same weight	Ball is heavier	Saucer is heaver	Total	Chi-Square cal	Chi-Square tab
8.	Which of the items is heavier?	13 (16.6)	36 (18.6)	7 (18.6)	56	94.75	5.991

From table seven above, the chi-square calculated is 94.75 which is greater than Chi-Square tabulated at df 2 and level of significance 0.05. The null hypothesis was rejected. Greater percentage of the pupils was not able to see that change in shape of solids does not affect the weight of such solid material.

Summary of the Findings

The result to a reasonable extent agrees with some of the findings of Piagets.

1. Pupils within the age group of (5-6) years tend to be confused if the relative position of objects is changed in terms of length.
2. Greater percentage of the pupils could not recognize that changes in the shapes of identical objects equal in size, shape and weight does not affect the weight.

3. Greater percentage recognized that the shapes contained the same quantity of clay but their responses tend to change if probed further.
4. The pupils showed more positive understanding in their ability to conserve number irrespective of the configuration or mode of presentation of the items or situation.
5. The pupils were weak in their ability to demonstrate understanding in the conservation of length of objects; weight and quantity of substances which their relative positions and shapes were changed respectively.

Educational Implications.

The educational implications are clearly articulated below.

1. Readiness to learn a number of mathematical tasks depends on the extent to which the child has acquired some experiences that will be a sufficient base for the new experiences to anchor.

   2 Mathematics concepts and language expressions must be properly and adequately exposed to the children at every stage.

3 Objects that are found in any given community should be used to improve understanding of mathematical concepts.

4 Mathematics will continue to appear abstract if the concepts are taught in isolation of the child's immediate environment and daily activities.

Recommendations

The following recommendations were made.

1. Primary school Mathematics teachers should teach every concept with concrete materials for meaningful understanding.
2. Teaching should be exploratory and experimental.
3. Teachers should be aware that the pupils think differently from the adult learner.
4. Teachers at this level should understand that any mistake made in handling the pupils at this stage may distort their foundation in every aspect in their further study of mathematics.
5. Readiness ability tests should be regularly administered on the recommended age group so as to be properly guided.

References

Bahr D.L & Garcia Lisa An (2010) *Elementary Mathematics is Anything but elementary*. Wadsworth 10 Davis Drive Belmont, USA

Clement, M (2014) *Six things that make college Teachers successful*.http: /www.facultyfocus.com/articles/faculty-Development Teaching careers

Ginsburg & Baroody (1990) in Sattler J.M (2001*) Assessment of Children*.

Ma,L (1999) *knowing and Teaching Elementary Mathematics: Teachers understanding of fundamental mathematics in China and United States:*Mahawah, NJ:Lawrence Erlbaum.

McAleavy ,T (2012) *Exploring Different Approaches to Teacihing*. www.sciencepub.com

NTI (n.d) *Post Graduate Diploma in education (PDE 108 research Methods in Education p.181).*

Piaget J (n.d) in Sattler (2001) Assessment of children

Sattler J.M (2001) *Assessment of children*. San Diego State University

Wolk, S(2001)*Benefits of Exploring Time*.in Weimer (2013). *Defining Effective Teaching*. Files://c:/ users/user/desktop/Defining Teaching Effectiveness.