# CONCRETE OPERATIONAL STAGE OF PIAGET'S COGNITIVE DEVELOPMENT THEORY: AN IMPLICATION IN LEARNING GENERAL SCIENCE

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**ABSTRACT**

*This research study was conducted with the aim to apply Concrete Operational Stage (7-11 years) of Piaget's Cognitive development theory in learning general science. Objectives of the study were to apply Concrete Operational Stage of Piaget's Cognitive development theory and to compare academic achievement of urban and rural students in the subject of general science falling in this Stage of theory. Sample of the study was comprised of two hundred students of age seven to eleven years. A self-developed test to measure the academic achievement of the students in the subject of general science was used as a research tool. Results of the study revealed that overall students falling in concrete operational stage of the Piaget' theory have the ability to solve the problems in learning general science up to some extent as well as in rural and urban context. However, urban school students falling in Piaget's concrete operational stage have better performance regarding the ability and to solve the problems of Chemistry, Biology, and Physics in general science than the rural students. It is concluded that socio-cultural environment (rural vs. urban) have impact on Piaget' concrete operational stage students in learning general science.*

**Keywords**: *Piaget's Theory, Concrete Operational Stage, General Science, Urban, Rural.*

## INTRODUCTION

Jean Piaget (1896 –1980) was the first Psychologist who presented a comprehensive theory regarding human cognitive development. It is also called cognitive developmental stage theory. But in fact, it deals with how humans gradually acquire knowledge, construct knowledge, and use knowledge (Wadsworth, 2003). According to Piaget, "Cognitive development was a progressive reorganization of mental processes as a result of biological maturation and environmental experiences. Piaget's theory consists of four stages: Sensorimotor: (birth to 2 years), Pre-operations: (2 to 7 years), Concrete operations: (7 to 11 years), and Formal Operations: (12 to 16 years) (Ojose, 2008). According to Piaget's theory children should not be taught certain concepts until they have reached the appropriate stage of cognitive development. As

several studies have shown Piaget underestimated abilities of children and his tests were sometimes confusing or difficult to understand (Hughes, 1975).

Science is a natural struggle for children who are asking questions, observing, touching and tasting. It contains awareness of self, living things, and the whole environment through our senses and investigation (McIntyre, 1984). Keeping in view science as a part of the childhood curriculum, cognitive abilities and limits of little children, it needs solid, visible, real and clear Science concepts (Smith, 1982).General science have vital role with cognition and thinking. This research study used cognitive development of concrete operational stage emphasizing learning in general science. Socio-Cultural differences of our locality i.e. schools locating in rural and urban areas are major factors which effect cognitive development particularly in learning general science. Therefore, this research study was aimed to apply the concrete operations stage (7-11 years) of Piaget's Cognitive development theory on students of age seven to eleven years at district Bannu in learning general science concepts (viz; Physics, Chemistry, Biology) in rural and urban context.

**Statement of the Problem**

The statement of the problem was to apply the concrete operations stage (7-11 years) of Piaget's Cognitive development theory on students of age seven to eleven years in learning general science concepts in rural and urban context at district Bannu, Khyber Pakhtunkhwa, Pakistan.

**Objectives of the Study**

The following were objectives of the study

1. To apply Concrete Operational Stage (7-11 years) of Piaget's Cognitive development theory in learning general science concepts (viz; Physics, Chemistry, Biology) on students of age seven to eleven years at district Bannu.
2. To compare academic achievement in learning general science concepts (viz; Physics, Chemistry, Biology) of rural and urban students falling in Piaget's Concrete Operational Stage (7-11 years) of cognitive development theory.

**Hypotheses of the study**

This study was guided by the following null hypotheses.

1. There is no significant difference in the concrete operational cognitive development stage of rural and urban students' ability in solving the problems of Chemistry in learning general science.

2. There is no significant difference in the concrete operational cognitive development stage of rural and urban students' ability in solving the problems of Biology in learning general science.
3. There is no significant difference in the concrete operational cognitive development stage of rural and urban students' ability in solving the problems of Physics in learning general science.

**Significance of the Study**

Piaget's theory on cognitive development is very famous all over the world. Pakistan is already below standard in educating its youngsters and social-cultural environment particularly rural areas are also unsound if compared with developed countries. The education system in Pakistan needs revolutionary efforts to improve the teaching-learning process. One of these efforts may include applying Piaget's cognitive development theory in our locality. The study is very significant for learners who are learning general science at primary and elementary level because it needs high reasoning ability. This study will be important for those teachers who are teaching general science subjects in understanding awareness students' cognitive development level and helpful in enhancing their cognitive learning ability.

**LITERATURE REVIEW**

Kellett G. (2008) explained that Cognition literally means "to know". Knowledge can be accepted wisdom or thinking of our mind memories which are formed from the manipulation of various raw input notions through our five senses. This knowledge is applied or used for taking action towards achievement of goals and therefore it is the basis of the cognitive development procedure. Wadsworth (2003) described that Cognitive development process is the formation and composition of thinking processes. Cognitive development includes information processing, intelligence, way of thinking, logic, analysis, language development, and recall.

Piaget (1977) explained that the sensorimotor stage starts from zero to two years. In this stage, awareness of the environment is creating in infants by coordinating practices through seeing something and hearing some sound along with physical action e.g. shaking hands. Infants achieve information, awareness, understanding, facts, and perception of the surrounding environment through physical and motor actions.

The 2$^{nd}$ stage of Piaget's theory on cognitive development is known as preoperational stage and it starts from two years age of the children to the closing of seven years age. In the beginning, children develop their language. During this age, children are able to

develop symbolic play and manipulate symbols, seeing order of games. Piaget observed that they have to face problems in seeing everything with various outlooks. Moreover, they did not know concrete things, logic and cannot work their thoughtful information. Jean Piaget stated that the end of 2nd year age of children is called a new type of psychological performance.

The 3rdstage of Piaget's cognitive developmental theory is called concrete operational stage. It begins with the children age of seven years and ends with the age of eleven years. Its characteristics are proper exercise of logic, reasoning, resolve difficulties, problems, and go through hindrances in a logical way. A child's thinking power is turned into further developed as well as grown up like adulthood in this stage. Children can solve those problems which are relevant to concrete actions or things. However, conceptual, theoretical and speculative thoughts have not developed in children so far. Children in the concrete operational stage usually practice problems in their mind when they solve logical questions e.g. a child can know and identify that A>B and B>C, but he cannot understand logically way of thinking that A is also greater than C. (Copeland, 1979).

According to Piaget (1964), these operations at the concrete level include those of classification (categorization), ordering (seriation), the construction of the idea of number, spatial and temporal (sequential) operations, and all the fundamental operations of elementary (basic and simple) logic of classes and relations of elementary mathematics, of elementary geometry and even of elementary physics. Essa (1999) also explained views of Ginsburg & Opper (1969) that the Concrete Operations Period children since concerning seven to eleven years grow old, young children build thinking skills, dependent on logic than on external appearances. While young children thinking abilities are considerably more logical than the preoperational period.

The last stage is known as formal operational stage (12 to 16 years). Intelligence or intellect or cleverness is confirmed owing to the logical or reasonable ways and using symbols connected with theoretical concepts. In formal operations stage, human being has ability of theoretical plus deductive logic or way of thinking. In the course of this period, individuals build up their capability of thinking and learning regarding theoretical methods. Piaget thought that deductive logical way of thinking is significant throughout this period. Deductive reasoning consists of theoretical situation which is essential mostly in natural sciences and math. Abstract thoughts also emerges at this period. Problem-solving is confirmed by individuals through the application of trial-and-error method for the solution of various troubles. The capability and

achievement of children for the solution of various troubles systematically in a rational plus methodical means emerges.

Copeland (1979) described that to properly classify objects; their relation to other objects already studied must be known. For example, consider a set of horses. Are they animals? To show such a relationship as a basis of classification, two circles may be drawn, one to represent horses, the other animals. The relative position of the circles shows the relation that exists between horses and animals. Logically, there are several possibilities. It is an idea used very often by Piaget as "class inclusion." Mayesky (2001) found that there are two things i.e. the child and the scientist do. They investigate (carefully study the world around them) to discover knowledge (find answers to questions or problems about that world). Science consists of two parts that cannot be separated: investigation and knowledge. Mayesky (2001) stated that there are three types of science experiences and activities for young children: formal science, informal science, and incidental science.

Children are certainly aware and interested in the weather, an appropriate topic for discussion with young children. Experiments, stories, and poems related to various weather phenomena such as rain, rainbow, the sun, the wind, snow, ice, clouds, and storms can be readily incorporated into the curriculum". Mayesky (2001), stated that aesthetics means being sensitive to beauty in nature and art. Such sensitivity is fostered not by talking about beauty but by experiencing it in a variety of forms-the sign of snow on evergreen branches, the smell of the earth after a spring rain, the sound of a bird singing overhead, etc. Mayesky (2001) explained that children can learn many different things regarding nature by being outdoors. However, many young children come to school with limited direct experiences with natural environments. Young children need to realize that nature is all around them and wildlife can be found anywhere.

## METHODOLOGY AND PROCEDURE

### Research Design

This study was survey type in nature.

### Population and Sampling

Population of the study was all male students of age seven to eleven years studying in public sectors schools of district Bannu. Sample of the study was comprised of two hundred students of age seven to eleven years who were selected randomly from the randomly selected schools of district Bannu.

**Instrumentation**

A self-developed objective type test based on the concrete operational activities of the general science (Chemistry, Biology, and Physics) was used to collect data from the sample. Validity of the instrument was checked through fifteen educationists and concerned subject teachers. For the reliability of the instrument, it was administered to fifty students and reliability coefficient Cronbach alpha value 0.80 was found.

One of the researchers personally administered respective test which was consisted of concrete activities in learning general science (viz; Chemistry, Biology and Physics) to the selected sample of two hundred male (one hundred from urban and one hundred from rural) students from public sector schools of district Bannu and collected answer sheets.

**RESULTS AND DISCUSSION**

The collected data was analyzed through SPSS 21 using percentage, mean, standard deviation and t- test. The following cut points of the mean values were used to interpret the descriptive results:

Below average = (0-0.67),
Average = (0.68-1.33),
Above average = (1.34-2).

**Table 1:** Showing scores, %age, Mean and SD on Analysis of Scores on Chemistry

| S. N | Questions | F | Scores | %age | M | SD |
|---|---|---|---|---|---|---|
| 1 | I feel cool when I am playing with snow**.** True/False | 71 | 0 | 35.5 | 1.29 | 0.96 |
| | | 129 | 2 | 64.5 | | |
| 2 | I feel pleasant when I am walking barefoot in the morning grass. True/False | 26 | 0 | 13 | 1.74 | 0.67 |
| | | 174 | 2 | 87 | | |
| 3 | Air is a _____ of different gases. | 87 | 0 | 43.5 | 1.13 | 0.99 |
| | | 113 | 2 | 56.5 | | |
| 4 | Write the names of different physical states of water. | 168 | 0 | 84 | 0.32 | 0.73 |
| | | 1 | 1 | 0.5 | | |
| | | 31 | 2 | 15.5 | | |
| **Overall scores** | | **216** | **0** | **44** | **1.12** | **0.52** |
| | | **1** | **1** | **0.125** | | |
| | | **584** | **2** | **55.875** | | |

Table 1 shows the academic achievement of the students falling in Piaget's concrete operational stage (7-11 years) regarding the ability to solve problems regarding chemistry. Overall mean scores (1.12) falls in the range (0.68-1.33) of average with SD= 0.52.

**Table 2:** Showing scores, %age, Mean and SD on Analysis of Scores on Biology

| S N | Questions | F | Scores | %age | M | SD |
|---|---|---|---|---|---|---|
| 5 | The horse has not been genuinely changed into a Zebra**.** True/False | 66 | 0 | 33 | 1.34 | 0.94 |
| | | 134 | 2 | 67 | | |
| 6 | _____system relate to your food digestion. | 103 | 0 | 51.5 | 0.97 | 1.00 |
| | | 97 | 2 | 48.5 | | |
| 7 | We feel various types of activities through _____. | 84 | 0 | 42 | 1.16 | 0.99 |
| | | 116 | 2 | 58 | | |
| 8 | The process of preparation of food in plants is called _____ . | 97 | 0 | 48.5 | 1.03 | 1.00 |
| | | 103 | 2 | 51.5 | | |
| 9 | What is the best time of year to watch for birds? | 41 | 0 | 20.5 | 1.59 | 0.81 |
| | | 159 | 2 | 79.5 | | |
| 10 | What time of day is best for birds watching at a feeder? | 47 | 0 | 23.5 | 1.53 | 0.85 |
| | | 153 | 2 | 76.5 | | |
| 11 | Are horses animals? | 103 | 0 | 51.5 | 0.97 | 1.00 |
| | | 97 | 2 | 48.5 | | |
| 12 | Why do animals need hiding places? | 98 | 0 | 49 | 1.02 | 1.00 |
| | | 102 | 2 | 51 | | |
| 13 | Is there a difference in growth with different amount of sunlight? | 81 | 0 | 40.5 | 1.19 | 0.98 |
| | | 119 | 2 | 59.5 | | |
| 14 | Is noise made by cars differing from noise made by trucks? | 111 | 0 | 55.5 | 0.89 | 0.99 |
| | | 89 | 2 | 44.5 | | |
| 15 | Can children create hiding places for themselves? | 127 | 0 | 63.5 | 0.73 | 0.97 |
| | | 73 | 2 | 36.5 | | |
| 16 | Draw a sketch of green house on paper. | 140 | 0 | 70 | 0.56 | 0.88 |
| | | 8 | 1 | 4 | | |
| | | 52 | 2 | 26 | | |
| 17 | What kind of game do you want to play in a playground? | 52 | 0 | 27 | 1.45 | 0.89 |
| | | 2 | 1 | 1 | | |
| | | 144 | 2 | 72 | | |
| 18 | Tell the names of birds having sweet sounds available in your locality. | 84 | 0 | 42 | 1.05 | 0.94 |
| | | 22 | 1 | 11 | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | 94 | 2 | 47 | | |
| 19 | Write names of different kinds of plants. | 78 | 0 | 39 | 1.18 | 0.97 |
| | | 8 | 1 | 4 | | |
| | | 114 | 2 | 57 | | |
| **Overall scores** | | **1314** | **0** | **43.8** | **1.12** | **0.44** |
| | | **40** | **1** | **1.33** | | |
| | | **1646** | **2** | **54.86** | | |

Table 2 shows the academic achievement of the students falling in Piaget's concrete operational stage (7-11 years) regarding the ability to solve the problems related to Biology for the general science. Overall mean scores (1.12) for performance in the Biology falls in the range (0.68-1.33) of average with SD= 0.44.

**Table 3:** Showing scores, %age, Mean and SD on Analysis of Scores on Physics

| S N | Questions | F | Scores | %age | M | SD |
|---|---|---|---|---|---|---|
| 20 | There are many colors in the clouds. True/ False | 65 | 0 | 32.5 | 1.35 | 0.94 |
| | | 135 | 2 | 67.5 | | |
| 21 | The sun may disappear, when clouds may join together. | 89 | 0 | 44.5 | 1.11 | 0.99 |
| | | 111 | 2 | 55.5 | | |
| 22 | Light and sun are sources of _____ | 36 | 0 | 18 | 1.64 | 0.77 |
| | | 164 | 2 | 82 | | |
| 23 | How do you feel trees sound without leaves? | 129 | 0 | 64.5 | 0.71 | 0.96 |
| | | 71 | 2 | 35.5 | | |
| 24 | Can human being hear sounds made by birds and animals? | 73 | 0 | 36.5 | 1.27 | 0.97 |
| | | 127 | 2 | 63.5 | | |
| 25 | Are thick grass or bushes serve as hiding places for animals? | 92 | 0 | 46 | 1.08 | 1.00 |
| | | 108 | 2 | 54 | | |
| 26 | How does a person feel if there is too much noise? | 118 | 0 | 59 | 0.68 | 0.87 |
| | | 28 | 1 | 14 | | |
| | | 54 | 2 | 27 | | |
| 27 | Write names of different kinds of energy. | 119 | 0 | 59.5 | 0.79 | 0.97 |
| | | 5 | 1 | 2.5 | | |
| | | 76 | 2 | 38 | | |
| **Overall scores** | | **721** | **0** | **45.06** | **1.08** | **0.45** |
| | | **33** | **1** | **2.06** | | |
| | | **846** | **2** | **52.86** | | |

Table 3 shows the academic achievement of the students falling in Piaget's concrete operational stage (7-11 years) regarding the ability to solve the problems related to Physics in the general science. Overall mean scores (1.08) for performance of the Physics falls in the range (0.68-1.33) of average with SD= 0.45.

**Table 4:** Comparison of Rural and Urban students' scores for the ability of Chemistry

| Location | N | M | SD | t-value | P-value |
|---|---|---|---|---|---|
| Rural | 100 | 0.92 | 0.50 | | |
| Urban | 100 | 1.07 | 0.57 | _2.84 | 0.01* |

d.f. =398 *p ≤ 0.05

The p-value (0.01*) in the above table shows that there is a significant difference between the academic achievement on chemistry of rural and urban students at 0.05 level of significance. Therefore, the hypothesis that there is no significance difference between the academic achievements of students in chemistry is rejected. However, it can be inferred that performance in chemistry of urban students with mean score M= 1.07 and SD= 0.57 is better as compared to the rural students with mean score M= 0.92 and SD= 0.50.

**Table 5:** Comparison of Rural and Urban students' scores for the ability of Biology

| Location | N | M | SD | t-value | P-value |
|---|---|---|---|---|---|
| Rural | 100 | 0.88 | 0.39 | | |
| Urban | 100 | 1.10 | 0.50 | _4.99 | 0.00* |

d.f. =398 *p ≤ 0.05

In table 5, the p-value (0.00*) show that there is a significant difference between the academic achievement in Biology of rural and urban students at 0.05 level of significance. Therefore, the hypothesis that there is no significance difference between the academic achievements in Biology of rural and urban students is rejected. However, it can be inferred that the performance regarding Biology of the urban students with mean score M= 1.10 and SD=0.50 is better than the rural students with mean score M= 0.88 and SD= 0.39.

**Table 6**: Comparison of Rural and Urban students' scores for the ability of Physics

| Location | N | M | SD | t-value | P-value |
|---|---|---|---|---|---|
| Rural | 100 | 1.01 | 0.39 | | |
| Urban | 100 | 1.07 | 0.45 | _1.37 | 0.01* |

d.f. =398 *p ≤ 0.05

Table 6 shows the p-value (0.01*) which means that there is a significant difference between the academic achievement in Physics of rural and urban students at 0.05 level of significance. Therefore, the hypothesis that there is no significance difference between the academic achievements in Biology of rural and urban students is rejected. However, it can be inferred that the performance regarding Physics of the urban students with mean score M= 1.07 and SD=0.45 is better than the rural students with mean score M= 1.01 and SD= 0.39.

## DISCUSSION

The academic achievement of the students falling in Piaget's concrete operational stage (7-11 years) regarding the ability of Chemistry, Biology, Physics indicates the students overall mean scores (1.12), (1.12), (1.08) falls in the range (0.68-1.33) of average value with M= 1.12, 1.12, 1.08 and SD= 0.52, 0.44, 0.45. It reveals the students' average ability to solve the problems of Chemistry, Biology, and Physics in learning general science in our rural and urban context. Keeping in view of Piaget's Theory, this study applied partially the concrete operations stage (7-11 years) of Piaget's Cognitive development theory on students of age seven to eleven years in our rural and urban context at district Bannu in learning general science concepts especially of Chemistry, Biology, and Physics.

The respective p-values (0.01*), (0.00*), (0.01*)for comparisons show that there was a significant difference between the academic achievement on chemistry, biology, physics of rural and urban students at 0.05 level of significance and all the null hypotheses were rejected. However, it can be inferred that the performance regarding chemistry, biology, physics of the urban students with mean score M= 1.07, M= 1.10, M= 1.07 and SD= 0.57, SD=0.50, SD=0.45 was better as compared to the rural students with mean score M= 0.92, M= 0.88, M= 1.01 and SD= 0.50, SD= 0.39, SD= 0.39. Vygotsky supported significance of a child's cultural environment deep effects on development periods. As various cultures or societies have dissimilar societal connections; these ideas challenged Piaget's theory on cognitive development. Seeing Vygotsky views, this study revealed that socio-cultural differences have impact on the concrete operations stage (7-11 years) of Piaget's Cognitive development theory on students of age seven to eleven years in rural and urban context at district Bannu in learning general science concepts because urban students were better than the rural students.

## CONCLUSIONS

It was concluded on the basis of data analysis and results after applications of Piaget's theory on concrete operational stage (7-11 years) that students of age seven to eleven years have the ability of Chemistry, Biology, and Physics to some extent in learning general science to some extent in our rural and urban context. Urban school students falling in Paget's concrete operational stage (7-11 years) have better performance regarding the ability of Chemistry, Biology, and Physics in general science than the rural students. It shows clearly that socio-cultural environment (rural vs. urban) have impact on Piaget's concrete operational stage students in learning general science. However, there may be some weaknesses in our text books which should be removed or refined.

**Recommendations**

- A comprehensive learning program for concrete operational stage students in learning general science should be introduced in all primary and elementary schools.
- Text books should be revised according to the mental level of students falling Piaget's concrete operational stage students in learning general science.
- Teaching strategies and A.V Aids in learning general science should be revised and teaching should be interesting and minimize the learning difficulties of the students.
- Teachers' workload of general science subjects should be minimized so that they give special attention to the students in teaching-learning process.
- General science learning is the base of modern scientific advancement. Therefore, policy makers should make such steps focusing general science for Piaget's cognitive development of the students at elementary level.
- Experimental and research based activities in laboratories should be started in all primary and middle schools for active participation of the students.
- Rural school students have less academic achievement regarding the ability of chemistry, biology and physics in general science. Therefore, inter-schools students' competition, experimental activities should be started under guidance of the experience teachers to motivate cognitive activities of the students in learning general science in all primary and middle schools level.

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