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A STUDY ON SRI LANKAN CHILDREN'S CONCEPTION OF SPACE

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ABSTRACT

The present study was conducted mainly to investigate the applicability of children's conception space presented in Piaget's Cognitive Development theory to Sri Lankan children. The study attempted to identify whether there were variations in Sri Lankan children's conception of space according to the sectors i.e. urban, rural and estate, they live in, factors affecting Sri Lankan children's conception of space. The methodology of the study was quantitative and in nature. Piagetian tests modified to suit the Sri Lankan context and the case study method was used in achieving the objectives of the study. The sample of the study consisted of 75 children selected randomly from primary school children between the ages of 5-10 years from Urban, Rural and Estate sectors in the Kalutara district of the Western Province. Modified Piagetian instruments, Observation schedules and in-depth interview schedules were used as instruments for data collection. The findings of the study indicated children's conception of space the findings revealed that Piaget's theory is applicable to Sri Lankan children in relation to haptic perception, projection of shadows of the rectangle but other tasks vary age wise and stage-wise. The results of the performance of Sri Lankan children spatial tasks, the study found that that there were no prominent variations in the performance in all three tasks. But the estate children's performance is slightly higher than that of other children in a few age ranges.

Keywords: piaget, space, Sri Lanka

INTRODUCTION

This study focuses on exploring the applicability of Jean Piaget's theory related to the child's conception of the mathematical concept 'space' to Sri Lankan children. Jean Piaget has been hailed as the most renowned developmental psychologist who studied how children develop cognitively (Carlson 1973; Gruber et al. 1995; Lutz et al. 2004; McLeod 2009).

Much of Piaget's theory was founded on the problems he presented to children of different ages. The concept of cognitive structure is central to his theory. Based on this theory, he described how children develop cognitively through four different stages. Piaget named these stages of development as Sensory motor stage (0-2 years), Pre-operation stage (2 to 7 years), Concrete operation stage (7 to 12 years) and formal operation stage (12 to 15 years). Each of these stages illustrates how intelligence develops in children and in particular, he showed with scientific evidence how children develop mathematical concepts across these stages (Piaget 1941). Over time many scholars have conducted studies in different regions to identify the universality of his theory (Kotalawala 1980; Maynard 2008; Dasen 2012). According to Maynard (2008) exploring cognitive development across cultures has allowed researchers to test, modify, and extend theories of development. By exploring the applicability of Piaget's theory on children's conception of conservation and space the researcher felt the present study would contribute to the enrich knowledge and practice in the field of education in Sri Lanka.

Space

According to Damon and Lerner, (2006) there is no single definition for the concept of space whichall scholars agree. However, they cite National Research Council Report (NRC Report) (2005) as the best definition of space referred to in 'spatial thinking', which the researcher found relevant to this study too. According to NRC Report spatial thinking has three dimensions namely, space representation and reasoning. Space for example is

> "*the relationship among units of measurement, different ways of calculating measurement, the basis of coordinate system and the nature of spaces"*
>
> Damon and Lerner (2006, p. 201)

Space perception according to Encyclopedia Britannica is the process through which humans and other organisms become aware of the relative positions of their own bodies and objects around them. Piaget and Inhelder (1948) state that Geometry primers are unanimous in presenting fundamental ideas of space as resting upon Euclidean concepts such as straight lines angles, squares circles measurement etc. However, a child's space is essentially an active operational character which invariably begins with a topological type of relationship long before it becomes projective or Euclidean.

In this study, 'space' is defined as the child's understanding of relative positions of his own body and objects around him and the conception of it begins from the topological type and progresses through the projective type to the Euclidean type.

STATEMENT OF PROBLEM

Numerous studies have been conducted to find out the universal applicability of Piaget's Theory (Griffiths et al. 1967; Chen et al.1983; Santrock 2001; Dasen 2012).Greenfield (1966) carried a series of researches among Wolof children in Senegal, West Africa, to identify whether 'concrete operational thought' in Piaget's theory is universal. She found only 50% of the children between the ages of 10-13 years understood the principle of conservation. Another study was conducted in Australia to find out whether the child's ability to use the concept of conservation improves if he comes from a culture where conservation is not widely practiced (Dasan et al. 1979). The study found that in Canberra even with training, aboriginal children were far behind the white children.

In contrast, a study conducted on children's understanding of spatial concepts found that the ability to deal correctly with spatial concepts improved with age (Dodwell 1963) as Piaget has stated but a clear progression from one type of thinking about space to a another was not evident. Citing empirical studies Newcomb et al. (2000), suggests that infants have the ability to identify specific locations in space. This has challenged Piaget's view that children do not achieve spatial competency until middle childhood.

Piaget developed his theory of cognitive development in a cultural context which is dissimilar to the Sri Lankan context. Nevertheless, the influence of Piaget's Cognitive development theory is evident in early childhood education and primary education in Sri Lanka. All the schools except international schools in Sri Lanka follow the National curriculum. The conception of conservation and Space are important in mathematics, physics and related subjects. There are disparities in

socioeconomic conditions among urban rural and estate sectors in Sri Lanka which may affect children's education. According to Sri Lanka Poverty Assessment (World Bank 2007) poverty is more prevalent in rural and estate sectors. The estate sector is known as a marginalized sector and it would be imperative to find if there are variations in the conception of these concepts in children living in different sectors. Therefore, the problem investigated under this study encompasses, the applicability of Piaget's findings on children's conception of conservation and space in general, and the variations in the conception of conservation and space according to the sector children live in and contributory factors to the development of the above concepts.

THERITICAL FRAMEWORK

Piaget was one of the most influential theorists in the field of Cognitive Development. He is known as a philosopher, biologist, educationist and psychologist. He explained how children develop knowledge and his findings are the main theoretical base of this study. Many researchers (Ramos 2011, Perkins et al. 2012) noted that, no theory has had a greater impact on developmental Psychology than that of Jean Piaget.

Piaget's theory of cognitive development is based on three main principles namely assimilation, accommodation and equilibrium (Huitt and Hummel 2003, Oakley 2004: 1-10). Assimilation is the process of taking in a new experience into the already existing mental structure. Schema was the name used by Piaget (1926) for this mental structure. Schema is a cognitive representation of activities or things. When a baby is born it will have an innate schema for sucking in order to ensure that it can feed and therefore grow. Piaget called the schema the basic building block of intelligent behavior (McLeod 2009). Children develop the cognitive structure to help them to make sense of their world and when they encounter a new experience they place this into schemas they have already developed. The process of assimilation is an active one. Children do not merely absorb knowledge but they actively engage in the assimilation process. Since they are selective they do not absorb all the information they encounter. Accommodation revises the existing schema according to the new experience. Piaget (1981) states that from the cognitive, perspective psychological assimilation may be perceptual, sensorymotor or conceptual and psychological accommodation is evident if the object resists assimilation into any existing schema. When an object does not resist too much to be assailable but still resists enough to cause accommodation, adaptation occurs (Piaget 1981). According to Bhattacharya and Han (2001), assimilation influences accommodation and vice versa.

Equilibrium is the force that drives the learning process (McLeod 2009). It occurs when the child's schema or cognitive structure can deal with most of the new information through assimilation.

As Gallagher and Ried (2002, p.177), describe Equilibrium is reached so that the active scheme is conserved and at the same time adapted to the objects properties. If these properties are unexpected and interesting the equilibrium can lead to the formation of a sub schema or even of a new schema which in turn needs to be equilibrated. If new information cannot be accommodated into existing schema disequilibrium occurs. Equilibrium therefore, occurs between assimilation and accommodation. An unpleasant state of equilibrium occurs when new information cannot be fitted into existing schemas or assimilated (McLeod, 2009).

Stages of Development

"A stage is a particular level, defined through three criteria –the level is prepared by the previous level and integrated in its successor level; the triple occur in an invariant order independent of age; all actions at that level have the same organization" Piaget (1967, p. 17)

According to Piaget (1953), all children go through four sequential stages of cognitivedevelopment. He named these four stages according to the characteristics of children's thinking. These stages are sensory motor stage, preoperational stage, concrete operational stage and formal operational stage A brief account of each of these stages is presented below.

Sensory Motor Stage (Birth - 2years)

Piaget's ideas on the sensory motor stage, focuses on the basis of a plan (Mays 1972). Piaget believed that much of a baby's behavior is triggered by certain stimuli, to which they reflex. A few weeks after birth, the baby begins to understand that some information he receives from the senses, and learns using certain muscles and members of motion (Piaget 1972b: 5362). These developments are known as action plans. Piaget (1952) divided the sensory motor stage into 6 sub stages namely Reflexes (birth to 1month), Primary circular reactions (1-4 months) Secondary circular reactions (4-8 months) Coordination and secondary circular reactions (8-12 months), Tertiary circular reactions (12-18 months) and Mental representation (18-24 months). Since babies are not able to find someone else to focus on the needs, desires or interests, they are considered to be & quot; ego-centered". During the sensory motor stage, knowledge about objects and how they can be manipulated is acquired. With the acquisition of information about themselves and the world and the people in it, the baby begins to understand how something can cause or influence each other and develop ideas about time and space. Babies have the ability to construct mental images of objects that surround them; the knowledge they have developed helps them to learn as to what can be done with the object. Piaget found that in the course of this development stage that when an object happens to be removed from their immediate presence. Around eight to twelve months, babies begin to search for hidden objects. This ability is defined as thedevelopment of the concept of 'object permanence'.

It is very relevant to cite the characteristics of the sensory motor stage described below in the Ormrod (2008) to get clear picture of human behavior. "As children move into more advanced stages of cognitive development they don't entirely discard sensori motor ways of interacting with the environment. Even as adults we continue to use the behavioral andperceptual schemes we acquired as infants (reaching and grasping, following a moving object with oureyes, etc.), and sometimes trial-and error experimentation is the only way to interact with a new and puzzling object".

Pre-operational stage (2 years-7 years)

Piaget's second stage of cognitive development is the pre-operational stage. This stage consists of two sub-stages namely symbolic thought and intuitive thought. During this stage, children's thought processes are developed although they are still considered too far from 'logic' (Wood et al. 2008). The vocabulary of a child has also extended and developed during this stage. Pre-operational children are usually ego-centered, meaning they see things from their own point of view, and imagine that everyone shares this view, because it is the only way they can understand the world.

Another characteristic of the pre-operational stage of a child is the development of 'symbolic thought'. It is the representation of reality through abstract concepts such as words, gestures and numbers (Molfese et al. 2002). Piaget entertained the view that imitation plays an important role in the development of symbolic thought because the child is able to imagine behaviors observed in the past and to recreate them as imitated behaviors.

Moral Realism " is another aspect of this stage. Children of this stage understand the concept but these are seen as external and unchallengeable. They evaluate misconduct by the consequences of it. Intentions of the person are not regarded when they judge wrongdoings.

Stage of concrete operations (7 years-11 years)

Piaget's third stage of the four stages of cognitive development is the Concrete operational stage. This stage includes 7-11 years (Piaget 1972 b). Piaget noted that, seriation, transitivity, classification, decentering, reversibility, conservation, and elimination of egocentrism are important processes in the concrete operational stage. According to Piaget (1972b), Seriation is the ability to sort objects in an order according to size, shape, or any other characteristic. Transitivity is the ability to recognize relationships among various things in a serial order. Classification is the ability to name and identify sets of objects according to appearance, size or other characteristic, including the idea that one set of objects can include another. Decentering is where the child takes into account multiple aspects of a problem to solve it. Reversibility is where the child understands that numbers or objects can be changed, and then returned to their original state. Conservation is the process where the child understands that quantity, length or number of items is unrelated to the arrangement or appearance of the object or items. Elimination of egocentrism is the ability to view things from another perspective. Children in this stage can, however, only solve problems that apply to actual (concrete) objects or events, and not abstract concepts or hypothetical tasks.

The child develops an ability to think abstractly and to make rational judgments about concrete or observable phenomena, which in the past was achieved through physical manipulation for the child to understand.

Piaget believed that children in the concrete operational stage can incorporate inductive logic. He also noted that children at this age have difficulty using deductive logic, which involves using a general principle to predict the outcome of a specific event (Santrock, 2008).

Stage of formal operations

According to Piaget and Inhelder (1958), formal operational stage begins at the age of 11. As adolescents enter this stage, they gain the ability to think in an abstract manner, the ability to combine and classify items in a more sophisticated way, and the capacity for higher-order reasoning (McLeod 2010). During this stage the child can do mathematical calculations, Think creatively, use abstract reasoning and see the outcome of an action. Tests devised by Piaget (1970: 45-67), show that children can use imagination and reasoning at this stage to solve problems.

METHODOLOGY

Both quantitative and qualitative methods were applied in collecting data. The quantitative method was applied to analyse data generated through modified Piagetian tests administered to identify Sri Lankan children's conception of space.

Population and Sample

The population of the present study is all Sri Lankan primary school (5- 10 years) children. However, for practical considerations the accessible population of the study was limited to Kalutara District in the Western province. Therefore, Primary schools (5- 10years) children in the Kalutara District were the population of this study. Kalutara District consists of three Education Zones and all three social sectors namely urban, rural and estate. The researcher found that this district was the most relevant district in the Western Province in achieving all the objectives of the study.

The ultimate sampling units of the study selected to achieve first two objectives were 75 primary school children between the ages of 5-10 years. They represented the age ranges: 5-6 6-7, 7-8, 8-9 and 9-10 years.

Instruments of the Study

There are numerous experiments conducted by Piaget to identify children's conception of spatial abilities. There are 15 tasks for the conception of spatial abilities. Since this study was to examine the applicability of children's conception space in Piaget's Theory, to Sri Lankan children, the instruments used by Piaget (1954) himself to test these concepts were used in this study. List presents a classification of his experiments used in testing the child's conception of conservation and space.

This was a paper and pencil test. To test the children's projection of shadows a 'vertical white screen' (The term used by Piaget) was set in front of a lamp the child was asked to sit facing the screen. The researcher switched the light on and showed his hand in different positions for the child to see the shadow of it on the screen. Then he switched off the light and showed the objects positioning them at different angles in the following way indicated in the Table 1.

Table 1 Objects and Positions for the Projective Task

Object	Positions
Pencil	• vertically, • horizontally, • point towards the light, • tilted
Disc	• **v**ertically, • horizontally, • tilted
Rectangle	• vertically, • horizontally, • tilted
Simple cone	• placed the cone vertex towards the light, • placed the cone base towards the light
Two cones common base	• placed the cones vertex towards the light, • placed the cones horizontally

Pierced cone	• placed the pierced cone vertex towards • the light • placed the pierced cone base towards the • light • placed the pierced cone vertically
Two cones common vertex	• placed point towards the light, • placed vertically

Source: Piaget's Book The Children Conception of Space

Then the child was simply asked to look at the shadows and draw the shape from the shadows he/she sees.

RESULTS

The results of this study is given below Table.

Table 2 Projection of shadows': Percentages of Correct Responses

Objects	**Positions**	**Item No**	**Age Groups**			
			5-6		**6-7**	
			Sri Lankan sample	**Piaget's Sample**	**Sri Lankan sample**	**Piaget's Sample**
Pencil	Vertical	S201	66.67	100	93.33	100
	Horizontal	S202	80	100	93.33	100
	Point towards the light	S203	33.33	-	0	0
	Tilted	S204	0	0	0	0
Disc	Vertical	S205	86.67	100	86.87	100
	Horizontal	S206	0	0	80	25
	Tilted	S207	0	0	6.67	0
Rectangle	Vertical	S208	13.33	0	66.67	50
	Horizontal	S209	0	100	0	-
	Tilted	S210	80	100	60	66.67
Cone	Vertex towards the light	S211	0	0	13.33	50
	Base towards the light	S212	0	0	20	0
Common vertex	Base towards the light	S213	0	0	6.67	0
	Horizontal	S214	0	0	0	0
Pierced cone	Vertex towards the light	S215	0	0	0	0
	Base towards the light	S216	0	0	0	0
	Vertical	S217	0	-	0	-
Common base cones	Point towards the light	S218	0	-	0	100
	Vertical	S219	0	-	0	100

Objects	**Positions**	**Item No**	**Age Groups**					
			7-8		**8-9**		**9-10**	
			Sri Lankan Sample	**Piaget's Sample**	**Sri Lankan Sample**	**Piaget's Sample**	**Sri Lankan Sample**	**Piaget's Sample**
Pencil	Vertical	S201	53.33	100	93.33	100	100	-
	Horizontal	S202	60	-	93.33	-	100	-
	Point towards the light	S203	40	25	93.33	100	93.33	-
	Tilted	S204	46.67	25	66.67	75	73.33	-
Disc	Vertical	S205	93.33	100	93.33	100	100	-
	Horizontal	S206	73.33	66.67	73.33	66.67	100	-
	Tilted	S207	33.33	20	73.33	66.67	66.67	-
Rectangle	Vertical	S208	93.33	100	93.33	-	100	-
	Horizontal	S209	80	-	8	-	100	-
	Tilted	S210	80	100	93.33	100	93.33	-
Cone	Vertex towards the light	S211	53.33	-	0	0	33.33	0
	Base towards the light	S212	60	50	0	0	53.33	0
Common vertex	Base towards the light	S213	93.33	100	26.67	-	93.33	100
	Horizontal	S214	86.67	100	26.67	-	100	100
Pierced cone	Vertex towards the light	S215	80	-	33.33	-	93.33	-
	Base towards the light	S216	93.33	100	53.33	100	66.67	-
	Vertical	S217	93.33	100	53.33	-	93.33	-
Common base cones	Point towards the light	S218	93.33	-	46.63		80.00	-
	Vertical	S219	100	100	93.33	-	100.0	-

Source: Calculations by the Author

According above Table the total sample of Sri Lankan children could draw the pencil in vertical and horizontal positions at the age of 9-10 years while the total sample of Piaget's study could draw it at the age of 5-6 years. However, data in the table show that a majority of Sri Lankan children (above 50%) could draw these positions from the age range of 5-6 years. The results of the tasks of drawing the pencil 'pointed towards light' and in tilted position seems to be hard for both Sri Lankan and Piaget's samples but a majority of the children in both samples have managed to catch it at the age of 8-9 years. Total sample in Piaget's study have achieved the first task (Point towards the light) at the age of 8-9 years while the total sample of Sri Lankan children could not achieve this task even at the age of 9-10 years. However, a considerable majority (93.33) of

children have drawn this position successfully at the age of 9-10 years. In both studies only a majority could draw the pencil in the tilted position. In Piaget's study 75% could draw this position at the age of 8-9 years while in the present study 73.33% could draw it at the age of 9-10 years.

As the above Table depicts drawing the disc in the vertical position was easy for both samples. A majority of children in the Sri Lankan sample (86.67%) and the total sample in Piaget's study (100%) could draw this position well at the age of 5-6 years. The disc in the vertical position as well as the tilted position was difficult for both Sri Lankan and Piaget's sample at the age of 5-6 years. However, the total sample of Sri Lankan children could conceive the vertical position at the age of 9-10 years. No data is available of his tests related to this particular task with 9-10 year old children but the table shows that 66.67% of his sample has the ability to conceive this position at the age of 8-9 years. Only 73.33% percent of the Sri Lankan sample has conceived the tilted position at the age of 9-10 years while 75% of Piaget's sample showed this ability at the age of 8-9 years.

In relation to the rectangle in the vertical position a sizable majority of children in the Sri Lankan sample (93.33%) and all the children in Piaget's sample could do this task successfully at the age of 7-8 years. The total sample of Sri Lankan children could draw the rectangle in the horizontal position at the age of 9-10 years while Piaget's sample could draw it at the age of 5-6 years.

As shown in Table the tilted cone was conceived correctly and drawn by Piaget's total sample at the age of 5-6 years while 93.33% of the Sri Lankan sample could draw it at the age of 9-10 years.

As shown in the Table conceiving positions of 'common vertex cones' seem to be difficult for both samples. The maximum percentage of children who could draw the vertex towards the light in Piaget's study was 50% at the age of 6-7 and in the Sri Lankan study 53.33% at the age of 7-8years. This ability has declined in both samples with age. The cone with its base towards the light was also difficult to conceive for all the children in both samples at the age of 5-6 years. However, 50% of children in the Sri Lankan study and 50% of the children in Piaget's study have conceived this position at the age of 7-8 years.

A majority of children seem to conceive pierced cone with its base towards light with age in both samples. At the age of 7-8 years 93.33% of Sri Lankan sample and 100% of Piaget's sample have conceived this position. Likewise, children in both studies have the ability to the conceive pierced cone in the horizontal position at the age of 7-8 years (86.67% in Sri Lankan study and 100% in Piaget's study). The task on the pierced cone positioned with vertex towards the light also yields somewhat similar results. At the age of 7-8 years a majority of (93.33%) the Sri Lankan sample and the total sample of Piaget's study could conceive this position.

The results of the final task related to projection of shadows reveal that a majority of children can conceive common base cone pointed towards the light at the age of 7-8 years (93.33% in Sri Lankan sample and 100% in Piaget's sample). However, the total samples in both studies have conceived the common base cone in the vertical position at slightly different age ranges (Piaget's sample at the age of 6-7 years and Sri Lankan sample at the age of 7-8 years)

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