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Determinants of Cognitive Skills Achievement in Mathematics of Elementary Pre-Service Teachers

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ABSTRACT
This study was conducted to determine the cognitive skills achievement in mathematics of 88 elementary pre-service teachers as basis for improving problem solving and critical thinking. Their cognitive skills achievement in mathematics was analyzed using Piaget's seven logical operations namely: classification, seriation, logical multiplication, compensation, ratio and proportional thinking, probability thinking, and correlational thinking. This study used descriptive and causal-comparative research design to describe the cognitive skills achievement and to determine the affecting factors. An adopted Test on Logical Operations (TLO) with a total score of 140 points was used. In overall performance, elementary pre-service teachers performed with sufficient understanding in dealing with the TLO. However, in each logical operation, students were found to have insufficient understanding in probability thinking and correlational thinking. Consonant to Piaget's beliefs towards children of 11 years old and above, results also revealed that majority of the respondents (59.09%) were categorized with skills at the formal level. Moreover, ANOVA and Regression Analysis showed that engagement in recreational activities, educational attainment of the mother and monthly family income significantly influenced and predicted the students' cognitive skills achievement in mathematics. This study concluded that not all the seven logical operations were completely developed among the respondents and suggested to develop learning activities, environment and materials that would promote development and improvement of various cognitive skills.

Keywords: Cognitive Skills Achievement in Mathematics, Piaget's Logical Operations, Elementary Pre-Service Teachers

INTRODUCTION

The cognitive skills achievement in mathematics serves as a basis for determining the mathematics ability of Filipino learners, and it is measured by the quantified measure of cognitive skills that an individual can perform in mathematics. Cognitive skills include reasoning, perception, and intuition, and they are used in the process of acquiring knowledge. The K to 12 Curriculum Guide for mathematics in basic education emphasizes problem-solving and critical thinking as twin goals of mathematics education, which require the use of cognitive skills. Piaget's theory of cognitive development describes the four stages of cognitive development and the cognitive skills and intelligence learned by children in a particular stage. College students, particularly elementary pre-service teachers, are ideally in the formal stage of cognitive development according to Piaget's theory, and they should be able to value mathematics, solve problems, and develop confidence. The seven logical operations, namely classification, seriation, logical multiplication, compensation, ratio and proportional thinking, probability thinking, and correlational thinking, are expected to be developed among them. It is imperative to determine if the process skills and the logical operations are already developed in them to hone their skills and develop their cognitive skills. A study was conducted to determine the cognitive skills achievement in Mathematics of the elementary pre-service teachers using Piaget's seven logical operations, and to determine some factors that could predict and explain differences in cognitive skills achievement. (Inhelder& Piaget, 1958; Scriven & Paul, 1987; Alcantara &Bacsa, 2017; Sternberg, 1986; Polya, 1980; Gamit, 2010; Allen, 2010).

Socio-Demographic Characteristics related to Cognitive Skills Achievement and Mathematics Performance

The relationship between sex and cognitive development or academic performance has been observed for years (Araza, 2017; Vecaldo, 2017; MacGregor, 2017; Acidre, 2015; Ballado, 2014; Ardila et al., 2011; Reilly, 2012; Roselli, 2009; Ayaydin&Ozbay, 2003). Araza (2017) in his study found out that there is no significant relationship between sex and mathematics achievement in logic, geometry, algorithm, mathematical analysis,

probability and statistics, and discrete mathematics among college students. Similar findings were obtained by Pascua et al. (2012) and Vecaldo (2017) with the college academic performance of teacher education candidates. Acidre (2015)investigated students' learning through sex groupings. It was concluded that males obtained a satisfactory performance while the females showed fair performance in mathematics achievement, yet there was no statistical disparity in the mathematics performance of the students, male or female group. The report of Ballado (2014) on Bachelor of Elementary Education students taking a course in Problem Solving revealed insignificant sex differences in mathematics achievement.

Meanwhile, Ardila et al. (2011) in their study, showed that there is gender differences in various indicators of cognitive development. Gender differences also emerged in the performance of mental mathematical operations and in resolving arithmetical problems indicating that male performed better than female (Roselli, 2009). In addition, males outperform girls in mathematics literacy (Reilly, 2012). However, according to Ayaydin and Ozbay (2003), females' problem-solving skills surpassed males in the university level. Despite female superiority, male pre-service teachers felt more confident in their ability to solve difficult mathematics problems (MacGregor, 2017).

Type of High School Graduated from

Several studies were conducted to determine the differences in cognitive skills achievement in mathematics and academic performance (Domingo, 2018; Nghiem et. al., 2015; Marks, 2015). School plays an important role in students' cognitive development as it is one of the major platforms for learning. In the Philippines, when the basic education in the country was composed of 6 years in elementary and 4 years in secondary school, the Department of Education (2006) reported that most students were enrolled in public schools (approximately 93% of elementary students and approximately 80% of secondary students).

In the study of Domingo (2018), he found that students from public junior high school had a significantly higher cognitive skills achievement than those in private junior high school. Nghiem et al. (2015) cited their findings that type of school did not affect the cognitive and non-cognitive abilities of children. In contrary, Marks (2015) claimed that students from non-government schools ranked higher than in government schools in a tertiary Admission exam.

Place of Residency

Some studies were conducted to determine the difference in academic performance between groups of students who live in urban and rural areas (Ghazi & Ullah, 2016; Domingo, 2018; Alokan&Arijesuyo, 2013)

The place where a person lives is considered as one of the external factors of cognitive development (Dutta, 2015). In the Philippine context, the Philippine Statistics Authority (2013) reported the level of urbanization in 2010 or the proportion of urban population to the total population was 45.3 percent. This means that of the 92.3 million population in the Philippines in 2010, 41.9 million lived in areas classified as urban. The rural population or those who lived in areas classified as rural numbered 50.5 million and accounted for 54.7 percent of the total population.

In the study conducted in Pakistan by Ghazi and Ullah (2016), their findings revealed that students from urban places performed significantly higher than students from rural areas in some cognitive skills such as conservation of numbers, ordering and seriation, and logical thinking.

However, one study in the Philippines showed that students from urban and rural areas are comparable in terms of cognitive skills achievement (Domingo, 2018). Another foreign study conducted by Alokan and Arijesuyo (2013) added that there is no significant difference in the academic performance between students from rural environment and urban environment.

Engagement in Recreational Activities

Articles about engagement in recreational activities claimed that it provides positive effect on mental health (Wang, 2012; Street et al., 2007).

Recreational activities or the works of individuals that are often done for enjoyment, amusement, or pleasure are considered to be fun that promote individual's self-amusement that have social, and psychomotor rewards (Dutta, 2015). In an article written by Street et al. (2007), people who participate in sports clubs and organized recreational activity enjoy better mental health and cognitive ability, are more alert, more resilient against the stresses of modern living and promote intellectual advancement. Participation in recreational groups and socially supported physical activity is shown to reduce stress, anxiety and depression, and reduce symptoms of Alzheimer's disease, yet more than one-third of adult Australians report no participation in sports and physical recreation. In addition, Wang et al. (2012) showed that leisure activities have positive impact on cognition and dementia.

Educational Attainment of the Parents

Parents' educational attainment plays significant role in academic performance of their children (Araza, 2017; Andaya, 2014; Wadley, 2014)

Krashen (2005) concluded that students whose parents are educated scored higher on standardized tests than those whose parents were not educated. More so, Fathers' and mothers' education had a significant effect on students' mathematics scores (Farooq et al., 2011).

Parents with higher level of education could be role models for their children to perform well in mathematics (Andaya, 2014). Parents who lack education as stated by Ntitika (2014), may not see its importance in their children, hence they may not be that supportive as compared to those parents who have some level of education and knowledge in the importance of education in their children's life. For instance, Araza (2017) found that college students math achievement is related to their mother's educational attainment. In an article written by Wadley (2014), she said that the amount of education she attains can predict her children's success in reading and math.

On the other hand, Hayali (2013) concluded that parent's level of college education had no significant impact on students' academic performance in college math courses. Students performed well or poorly, irrespective of their parents' educational achievement. Furthermore, Escarlos and Tan (2017) documented insignificant relationship between pre-service teachers' academic performance with their parents 'educational attainment.

Monthly Family Income

According to the National Statistical Coordination Board (NSCB) now known as the Philippine Statistics Authority (PSA) based on Family Income and Expenditure Survey in 2009, the income classes are Low Income (P0.00 – P11,914.50), Middle Income (P11, 915.00 – P49, 526.00) and High Income (P50,000.00 and up). Monthly family income is the state to which an individual belongs in a group categorized by their monthly household income. In this study, socio-economic status (SES) is associated with income since the SES is highly predicted by household income.

Socioeconomic standing of an individual defined by his or her family net income could have an impact to his/her academic achievement in school. Kirkup (2008) revealed that students with high level of SES perform better than the middle-class students and the middle-class students perform better than the students with low level of SES. Farooq et al. (2011) found that socioeconomic status has a significant effect on students' overall academic achievement as well as achievement in mathematics.

However, Alver (2005), in his study, showed that on the problem-solving skills and academic success, university students realized that high, middle or low socioeconomic situation does not influence problem solving skills. Similarly, Escarlos and Tan (2017) recorded insignificant relationship between teacher education students' academic performance and family income.

Cognitive Development and Its Stages

Jean Piaget's work on children's cognitive development, specifically with quantitative concepts, has garnered much attention within the field of education. Piaget explored children's cognitive development to study his primary interest in genetic epistemology. Upon completion of his doctorate, he became intrigued with the processes by which children achieved their answers; he used conversation as a means to probe children's thinking based on experimental procedures used in psychiatric questioning. One contribution of Piagetian theory concerns the developmental stages of children's cognition. His work on children's quantitative development has provided mathematics educators with crucial insights into how children learn mathematical concepts and ideas. This article describes stages of cognitive development with an emphasis on their importance to mathematical development and provides suggestions for planning mathematics instruction (Ojose, 2008).

Cognitive development is one of the most essential aspects of growth in a child. It encompasses both mental or cognitive skills and emotional growth. There are many factors that determine the progress of cognitive development. These factors are important in both the unborn child and infants as they grow. Dutta (2015) listed these as biological factors which include hereditary aspects, nutritional factors and sensory organ, and environmental factors such as economic factors, external stimuli, family and society, and play.

Piaget believed that the development of a child occurs through a continuous transformation of thought processes. A developmental stage consists of a period of months or years when certain development takes place. Although students are usually grouped by chronological age, their development levels may differ significantly (Weinert and Helmke, 1998), as well as the rate at which individual children pass through each stage. This difference may depend on maturity, experience, culture, and the ability of the child (Papila& Olds, 1996). According to Berk (1997), Piaget believed that children develop steadily and gradually throughout the varying stages and that the experiences in one stage form the foundations for movement to the next. All people pass through each stage before starting the next one; no one skips any stage. This implies older children, and even adults, who have not passed through later stages process information in ways that are characteristic of young children at the same developmental stage (Eggen & Kauchak, 2000).

Piaget has identified four primary stages of development: sensorimotor, preoperational, concrete operational, and formal operational. In the study of Decano (2017), these stages are defined as follows:
The Sensorimotor Stage (Birth to 2 years old) is the first stage Piaget uses to define cognitive development. During this period, infants are busy discovering relationships between their bodies and the environment. Researchers have discovered that infants have relatively well-developed sensory abilities. The child relies on seeing, touching, sucking, feeling and using their senses to learn things about themselves and the environment. Piaget calls this the sensorimotor stage because the early manifestations of intelligence appear from sensory perceptions and motor activities.
In the Preoperational stage (ages 2 to 4), a child will react to all similar objects as though they are identical. This means the child will make inferences from one specific to another. In this stage, the child is not yet able to conceptualize abstractly and needs concrete physical situations. Objects are classified in simple ways, especially by important features.
During this Concrete operation (ages 7 to 11), children begin to reason logically and organize thoughts coherently. The have the ability to master most types of conservation experiments and begin to understand reversibility. They are capable of concrete problem-solving. However, they can only think about actual physical objects and cannot handle abstract reasoning. They have difficulty understanding abstract or hypothetical concepts. This stage is also characterized by a loss of egocentric thinking. As suggested by Lawson and Renner (1974), a concrete operational student does not become formal operational by constantly being confronted with formal operational tasks or concrete.
In Formal operations (beginning at ages 11 to 15), the child does not require concrete objects to make rational judgments. He or she is capable of deductive and hypothetical reasoning. The Formal Operational stage is the final stage in Piaget's theory. It begins at approximately 11 to 12 years of age and continues throughout adulthood. They are characterized by the ability to formulate hypotheses and systematically test them to arrive at an answer to a problem.
Ojose (2008) stated that the development of children continues through a series of continuous transformation that were attributed to different levels of cognitive functioning. Children remained in each of these levels for an amount of time that varied. As a result of changes in cognitive structure, children progress in their cognitive ability with the preceding cognitive structure serving as the foundation for the new level of cognitive development. However, the transition of children through these levels was not predetermined or a result of chronological age. It was rather a designation of maturity, experiences, culture, and ability. All children, however, do transition through these levels chronologically or in the same order without skipping a level.

Cognitive Skills and Logical Operations

Cognitive skills are any mental skills that are used in the process of acquiring knowledge. These skills include reasoning, perception and intuition (Inhelder& Piaget, 1967). Different cognitive skills are learned as the child grows up.
The National Council of Teachers of Mathematics (2003) supported the idea that the major goal of school mathematics program is to create autonomous learners. However, it is only possible when students have acquired the necessary understanding (Ibañez, 2009). Apparently, learning mathematics involves formal operational thoughts which are found in the concrete and formal stages, that is, cognitive skills are deemed necessary.
Piaget's concept of logical thinking as presented in two of his books (Inhelder& Piaget, 1958 & 1967) has been extensively studied and utilized for the purpose of science and mathematics teaching at all levels (Gamit, 2010). Piaget emphasized the need to understand the concept of logical operations. He defined these operations in terms of actions that can be carried out in thought as well as in actual execution. Leongson and Limjap (2003) simplified the definitions of the seven logical operations. In classification, individual makes reference to variables or numerical properties involved in groupings. In seriation, children begin to reason relative to a set of attributes or numerical properties for ordering. Logical multiplication tells that individual makes reference to categories, relations or functions as they are applied to multiplication. If a child was able to refer to the reason property used for balancing, he performed compensation. Ratio and proportional thinking refer to relative magnitude of the increase and decrease of ratio. Individual can reason in time of the likelihood of possible outcome in probability thinking. Lastly, correlational thinking says that child can reason with relationship of variables or symbols.

Cognitive Skills Achievement

Several studies were executed to determine the cognitive skills achievement in mathematics (Leongson&Limjap, 2003; Gamit, 2010; Pagay, 2008; Decano, 2017).
Cognitive skills achievement is the quantified measure for the cognitive skills. In this study it was defined as the result of the Test on Logical Operation (TLO). The Test of Logical Operations (TLO) in Mathematics, which is the main instrument of this study was designed and constructed on the basis of Piaget's seven logical

operations. It is believed that an individual student has to utilize these operations while learning concepts in mathematics, and the sciences (Leongson, 2001).

In the study conducted by Leongson and Limjap (2003) and Gamit (2010) on cognitive skills achievement of college freshmen, they cited the findings freshmen fall under concrete operational stage in contrary to the notion of Piaget that these college freshmen age ranging 16-19 years should perform logical operation with mastery. An alarming result of both studies showed that students had sufficient understanding of problems on logical multiplication only and insufficient understanding of the problems using the other six logical operations.

Decano (2017) studied also the cognitive skills achievement of college students where majority of them are said to be in concrete operational stage. Moreover, Domingo (2018) in the same study in Grade 12 Senior High School students, found the result in consonance with the studies conducted by Leongson and Limjap (2003), Gamit (2010) and Decano (2017). His findings revealed a more alarming result in which they had low understanding in probability thinking and insufficient understanding fo the rest of logical operations.

However, Pagay (2008) studied the cognitive skills achievement of ten (10) pre-service mathematics teachers wherein all of them were considered in the formal operational stage which is sound positive to the cognitive development.

Different studies adhered that logical operational thought skills should be developed among students in order to have high mathematics achievement. Foster (2014) supported this notion citing that cognitive skills have significant positive correlation in problem solving test scores in mathematics. Moreover, Bahar (2013) revealed that cognitive abilities are positively related with mathematics problem solving performance.

Summary of Review of Related Literature

This study which aimed to determine the cognitive skills achievement in mathematics of elementary pre-service teachers and some factors that could explain differences in cognitive skills achievement is supported and guided by the previously cited literatures and studies. All these topics reviewed were covered in the study where similarities and/or differences were anticipated to be established. Sex was among the variables commonly related with mathematics achievement and cognitive skills. The study assumed that males' and females' problem-solving performances were comparable. This assumption corresponded to the conclusions of Araza (2017); Vecaldo (2017); Ballado (2014) but inconsistent with MacGregor (2017); Ardila et al. (2011); Reilly (2012); Roselli (2009) and Ayaydin and Ozbay (2003). Type of high school graduated from had bearing on students' academic performance. This is consonant with Mark (2015); Domingo (2018) but in contrary with Nghiem et al. (2015). Place of residence played role in the development of cognitive skills achievement. This agreed with Ghazi and Ullah (2016) and disagreed with Domingo (2018). Engagement in recreational activities promoted better mental health and intellectual advancement. This was supported by Street et al. (2007); Wanget. Al (2012). Educational attainment of the father and mother wa a factor that affected academic performance of students. This was supported by Farooq et al. (2011); Krashen (2005) but not for Escarlos and Tan (2017); Hayali (2013) claimed that parents' educational attainment had no relationship with academic performance. Studies revealed that monthly family income was a significant factor that affected students' performance. This was revealed by Farooq et al. (2011); Kirkup (2008). However, a contrasting idea was found by Tan (2017); Alver (2005). This study which aimed to determine the cognitive skills achievement in mathematics of elementary pre-service teachers using Piaget's Test on Logical Operations hoped not to encounter similar findings where the subjects of the study have: lower cognitive skills achievement and are considered in the concrete operational stage of Piaget's Theory of Cognitive Development (Domingo, 2018; Decano, 2017; Gamit, 2010; Leongson&Limjap, 2003), and have insufficient understanding in most of the logical operations (Domingo, 2018; Gamit, 2010; Leongson&Limjap, 2003). However, the researcher asserted that the elementary pre-service teacher respondents have high cognitive skills achievement and sufficient understanding on the seven logical operations like the one found by Pagay (2008).

Objectives of the Study

This study was designed to determine the cognitive skills achievement of the pre-service teachers in Basic Mathematics. Specifically, the study aimed to:

1. describe the respondents in terms of sex, type of high school graduated from, place of residence, engagement in recreational activities, educational attainment of the father, educational attainment of the mother, and monthly family income;
2. determine the elementary pre-service teachers' cognitive skills achievement in Mathematics;
3. determine the elementary pre-service teachers' categorization of cognitive skills based on their cognitive skills achievement in Mathematics;
4. find the differences in cognitive skills achievement in Mathematics between groups of respondents according to sex, type of high school graduated from, place of residence, engagement in recreational activities, educational attainment of the father, educational attainment of the mother, and monthly family income;

5. determine the predictors of elementary pre-service teachers' cognitive skills achievement in Mathematics based on their sex, type of high school graduated from, place of residence, engagement in recreational activities, educational attainment of the father, educational attainment of the mother, and monthly family income.

METHODOLOGY

Theoretical Framework Used

Several theories have been developed to explain cognitive development of children. One of them is the Piaget's theory which continues to be an adequate theory of intellectual development despite the various non-Piagetian theories that evolved. Piaget's theory served as the basis of this study and it is divided into two subparts, namely: Piaget's Theory of Cognitive Development, and Piaget's Logical Operations.

Paradigm of the Study

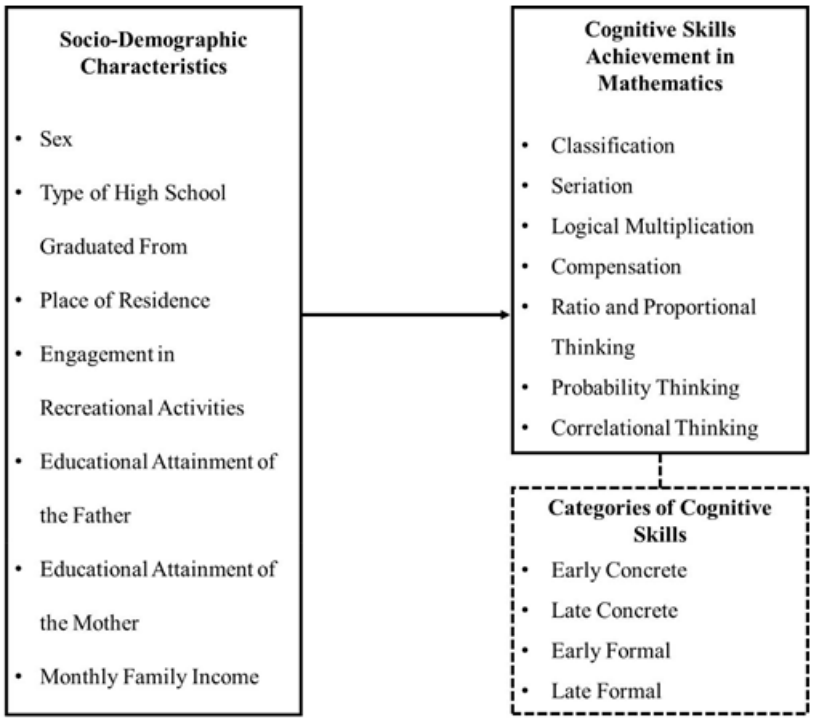

Figure 1: Paradigm of the Study

The research paradigm (Figure 1) revolved on testing the influence of independent variables (socio-demographic profile) on dependent variable (cognitive skills achievement in mathematics) and the categorization of their cognitive skills.

Research Design

The study used a descriptive research design utilizing the use of questionnaire to describe the cognitive skills achievement in basic mathematics of elementary pre-service teachers in CLSU. Descriptive research design is a purposive process of gathering, analyzing, classifying, and tabulating data about prevailing conditions, practices, beliefs, processes, trends, and cause-effect relationships and then making adequate and accurate interpretation about such data with or without the aid of statistical methods (Calderon & Gonzales, 2016). The study also used a causal – comparative design to investigate the difference in cognitive skills achievement in mathematics group of respondents according to sex, type of high school graduated from, place of residence, engagement in recreational activities, educational attainment of the father, educational attainment of the mother, and monthly family income. A causal-comparative design is a research design that seeks to find relationships between independent and dependent variables and the researcher's goal is to determine whether the independent variable affected the outcome, or dependent variable, by comparing two or more groups of individuals (Salkind, 2010).

Research Locale and Time of the Study

The study was conducted at the College of Education, Central Luzon State University (CLSU). It is situated in Science City of Muñoz, Nueva Ecija. CLSU is considered as one of the renowned and prestigious state-institutions of higher learning in the country. It is designated by the Commission of Higher Education (CHED) as Center of Excellence in Agriculture, Center of Excellence in Agricultural Engineering, Center of Excellence in Biology, Center of Excellence in Fisheries, Center of Excellence in Teacher Education, and Center of Excellence in Veterinary Medicine. The University caters students from different municipalities and nearby provinces in Region III. Further, this study was conducted on the first semester of academic year 2018 to 2019. It commenced on August 2018 and the final manuscript was completed in December 2018.

Respondents of the Study

Respondents of the study were the 88 elementary pre-service teachers (Bachelor of Elementary Education fourth year students) currently enrolled at the College of Education, Central Luzon State University during first semester of A.Y. 2018-2019. The respondents were chosen from this institution since these pre-service teachers will soon be in-service teachers of the different municipalities or cities in Nueva Ecija and nearby provinces where low performance of elementary pupils in mathematics is prevalent. This study used purposive sampling design in selecting the respondents of the study. Purposive sampling design also known as judgmental sampling is a deliberate sampling technique where the researcher uses his good judgement in selecting the respondents who best meet the purposes of the study (Ariola, 2006). Purposive total enumeration of elementary pre-service teachers of the College of Education, CLSU where all students present during the conduct of the study was considered respondents.

Research Instrument

This study used a questionnaire which included two (2) parts. The first part comprised the socio-demographic characteristics of the respondents such as sex, type of high school graduated from, place of residence, engagement in recreational activities, educational attainment of the father, educational attainment of the mother, and monthly family income. The second part was a validated teacher-made test developed by Gamit (2010) called the Test on Logical Operations (TLO) and it was adopted and modified for the purpose of this study. The TLO is a test which is limited to topics finished in high school mathematics courses and taken again in the two required mathematics courses, Fundamentals of Mathematics and Contemporary Mathematics, of the Teacher Education Curriculum, which basically include the selected topics in geometry, arithmetic, statistics and algebra. Items in geometry consisted of problems on angle measures, angle relation and area. The problem solving test in algebra consists of problems in algebraic expression, factoring, special products, solving equations, progressions, number and distance problems and others while arithmetic include percentage, ratio and proportion, fraction, decimals and conversion techniques. Some measures of central tendency like mean, median and mode computations, probability and correlations are included in statistics (Gamit, 2010). To determine the distribution of test items, a table of specification was used. The validity of the adopted TLO from Gamit (2010) was established by asking the experts to examine the test. Moreover, the instrument was administered to randomly selected first year students of the Central Luzon State University in the year 2010. Results of the test were item-analyzed in order to determine its discrimination and difficulty indices and which items were classified as good, marginal and/or poor items. Good items were retained in the questionnaire, while marginal items were modified and improved. Poor items were automatically discarded and replaced. The reliability of the adopted instrument was determined using split – half method and the reliability coefficient was computed using Kuder – Richardson formula which resulted to 0.763. This implied that the instrument is reliable (Gamit 2010). Moreover, the reliability of the instrument was redetermined for the fourth-year elementary pre-service teachers during the second semester of A.Y. 2017 – 2018 with the same reliability test and the computed reliability coefficient is 0.794. This also implied that the instrument is reliable for elementary pre-service teachers. The respondents were asked to place a check (/) for each characteristic that described them in the first part of the instrument. Respondents answered part two, the TLO, based on what were asked for its sub-parts. On the items for classification, the respondents encircled their answer among the choices, while on the items for seriation, the respondents supplied the missing term(s) as the answer for each item. For logical multiplication, compensation, ratio and proportional thinking, and probability thinking, respondents were asked to solve each problem in each logical operation. On the items for correlational thinking, respondents logically analyzed and determined the relationship between two variables. All items were problem solving, thus, solution for each problem was required to show and it served as basis for scoring. The TLO in Mathematics has a total score of 140 points. Each of the seven logical operations is scored twenty (20) points. Classification and seriation, both having 10 points, are given two points each item. Items on logical multiplications, compensation, ratio and proportional thinking, and probability thinking composed of five (5) items each and each item is given four (4) points per item since those questions are all problem solving, thus, solution is required to show. A scoring rubric proposed by Raven (1973) was used. Correlational thinking composed of five items is given also

four (4) points each item. In describing the respondents' cognitive skills performance in each logical operation in the TLO, the multiple – count scoring scheme proposed by Schoenfield (1982) was used. Respondents who scored from 0 to 5.0 were given a qualitative description as low understanding. Respondents who garnered 5.1 – 10.0 points showed insufficient understanding while those who scored 10.1 – 15.0 executed sufficient understanding. More so, qualitative description of complete understanding was given to those respondents who scored 15.1 – 10 points in each logical operation. In the study conducted by Pagay (2008), he described learner for each of these categories. A respondent exhibited "low understanding" of the problems in logical operations if he was not able to demonstrate or perform logical operations expected of him in standard procedure. Specifically, a student who possesses this quality had difficulty in solving mathematical problem under logical operations described. In addition, he failed to grasp or possess the required qualities, which was manifested by his partial understanding of the task presented. A respondent exhibited "insufficient understanding" of the problem if the most he can do was interpret the problem correctly and made an overt explanation of the solution of the problem. A respondent showed "sufficient understanding" of the problem in logical operations if he was able to demonstrate or perform the usual standard logical operations expected of him. Specifically, a student who exhibited this quality had the ability to do the required mathematical tasks assigned to him utilizing the expected logical operations in a normal or in good manner. A respondent manifested "complete understanding" of the problems in logical operations if he had the capabilities and potentials regarded as beyond what was expected of him. He showed complete understanding of the essence and structural relations of data in the problem. Also, he exhibited this characteristic if he had the ability to understand and grasp fully the mathematical task presented to him and solve it with logical representations. In addition, learners of this category can deal and perform problem of higher order of difficulty. Mistakes committed were minor.

To determine the respondents' category of cognitive skills based on their cognitive skills achievement, their scores were categorized. The categorization of cognitive skills was proposed by Raven (1973). Respondents who scored from 0 to 35 points were classified in early concrete. These were respondents who made no attempt to solve the problem or made attempt in the form of sketches; jotting down needed relationships; jotting down needed data; or overtly explaining how to solve all the problems of the test. They performed initial actions on the problem but were not able to progress to a higher level of performance. They may be able to solve some problems, but these were those that required the use of logical operations on very familiar mathematical concepts only. There were many inconsistencies in the solutions and thus, the scores were kept at the minimum. There was very little evidence of attainment of the reasoning patterns in mathematics at the concrete level. Respondents under this category showed poor comprehension of the logical operational problems by not being able to determine the problem goal correctly. More so, they were unable to see the correct relationships among the pieces of information in the problem as manifested by their incorrect representation of the problems. Respondents were tagged late concrete who scored 36 – 70 points. These were respondents who showed understanding of the problems given on each logical operation by the representations and early attempted that they made to solve all the problems. They may be able to solve more problems that required the use of logical operations on the basic mathematical concepts, thus the scores gained were better. There were major inconsistencies though in the solutions, just like those who belonged to the preceding category. There was no strong evidence of attainment of the reasoning patterns in mathematics at the formal level/stage. Other reason that may lead to the low score was the incomplete solution given by the students. While the solution may be logical, essential errors were committed. Thus, they were able to pursue the sub-goal but failed to arrive at the main goal of the problem.

Respondents who garnered 71 – 105 points were classified at early formal. These were students who made a great progress in the solutions, where problems on all logical operations were nearly solved, and whose solutions were correct but minor errors were committed on all of the items of the test. There were some evidences of the attainment of reasoning patterns in mathematics at the formal level. Their thinking processes were clearly manifested in the problem solution that they gave. Respondents under this category were able to show a connection between steps or ideas that showed how the problem was solved but minor errors in representations, strategies and relationships were committed. There was success in solving problems in almost all logical operations.

For late formal respondents with scores of 105 – 140 points, they were respondents who fully and correctly solved almost all the logical operational problems. There was strong evidence of the attainment of reasoning patterns in mathematics at the formal level. Students clearly articulated their thought processes by giving correct solutions most of the time. Students under this category were able to demonstrate a global understanding of the problem, employed a cognitive schema which facilitated the understanding of problem structure, chose and utilized the appropriate solution strategies, and successfully attained the correct answer.

Data Collection

The answers on the questionnaire provided were analyzed by descriptive analysis, and analysis of variances using Statistical Package for Social Sciences (SPSS) in the university.

To address the first objective, descriptive statistics such as frequency and percentage were employed to describe the respondents in terms of socio-demographic characteristics such as sex, type of high school graduated from, place of residence, engagement in recreational activities, educational attainment of the father, educational attainment of the mother, and monthly family income. To address the second objective, descriptive statistics such as mean and rank were employed to determine the elementary pre-service teachers' cognitive skills achievement in mathematics.

To address the third objective, descriptive statistics such as frequency and percentage were utilized to determine the elementary pre-service teachers' categorization of cognitive skills based on their cognitive skills achievement in mathematics.

To address the fourth objective, a series of Analysis of Variance (ANOVA) was used to determine the difference in cognitive skills achievement in mathematics between group of respondents according to sex, type of high school graduated from, place of residence, engagement in recreational activities, educational attainment of the father, educational attainment of the mother, and monthly family income. A follow up post-hoc analysis using Tukey HSD test was also used for non-dichotomous variables.

A multiple linear regression analysis was utilized to determine the significant predictors of elementary pre-service teachers' cognitive skills achievement in mathematics based on their sex, type of high school graduated from, place of residence, engagement in recreational activities, educational attainment of the father, educational attainment of the mother, and monthly family income to address the last objective of the study.

RESULTS AND DISCUSSIONS

Respondents' Socio-Demographic Characteristics

Table 1: The Socio-demographic characteristics of the respondents

Socio-Demographic Characteristics	F (N=88)	%
Sex		
Male	20	22.73
Female	68	77.27
Type of High School Graduated From		
Public	64	72.73
Private	24	27.27
Place of Residency		
Rural	68	77.27
Urban	20	22.73
Engagement in Recreational Activities		
Engaged	43	48.86
Not Engaged	45	51.14
Educational Attainment of the Father		
Elementary	8	9.09
High School	43	48.86
College	31	35.23
Graduate Studies	6	6.82
Educational Attainment of the Mother		
Elementary	3	3.41
High School	41	46.59
College	28	31.82
Graduate Studies	16	18.18
Monthly Family Income		
Low Income	61	69.32
Middle Income	22	25.00
High Income	5	5.68

Most of the respondents were females (77.27%) as shown in Table 1. This attested to the notion that, in the country's educational system, teaching is predominated by females in all levels of education. Assessment of NEUST Laboratory High School K-12 curriculum based on content and objectives

The results showed that majority of the respondents graduated from public high school with 64 elementary pre-service teachers or 72.73 percent. This result was similar to the report of Department of Education on 2006 that

almost all of the students were enrolled in public schools (93% of elementary students and 80% of secondary students).

Most of the respondents came from rural residence (77.27%) and the remaining 22.73 percent indicated that they live in the urban areas. With this result, it revealed that majority of the students in Central Luzon State University (CLSU) live in the rural areas. Considering the location of CLSU, it is expected to cater more local students coming from neighboring municipalities and provinces which are considered rural.

Data revealed that majority of the respondents (45 or 51.14%) were not engaged in recreational activities. Considering CLSU as an academic institution, the results affirmed that students are more on academics.

As presented in Table 1, almost half of the respondents (48.86%) had fathers who earned high school level of education which is lacking minimum requirement for employment. This denoted that the fathers of the respondents had low economic employability which may result to a lower family income. Thirty-one or 35.23 percent earned college degrees, while 6 or 6.82 percent finished master's or doctoral degrees. The rest (9.09%) of the fathers of the respondents graduated elementary level.

In terms of educational attainment of the mother, there were 41 or 46.59 percent of the respondents whose mothers finished high school level of education. Twenty-eight or 31.82 percent earned college degrees, while 16 or 18.18 percent earned graduate studies. The rest (3.14%) of the respondents' mothers completed elementary level.

Gathered data revealed that among the total number of the respondents, majority (69.32%) had a monthly family income of Php0.00 – Php11, 914.50 which is considered low according to Family Expenditure and Income Survey (2009) of Philippine Statistics Authority. The result was in conformity with the study of Bation and Sabaldana (2018) that the respondents' monthly gross family income was below minimum. One-fourth or 22 respondents had middle income (P11, 915.00 – P49, 526.00). While the remaining 5 or 5.68 percent came from a high generating-income family.

Respondents' Cognitive Skills Achievement in Mathematics

To address the second objective of the study, the performance of the respondents in each logical operation was gathered and analyzed in order to determine their level of understanding. The multiple – count scoring scheme proposed by Schoenfield (1982) was used to determine the qualitative description for each performance. Table 2 shows the summary of gathered logical operation.

Table 2: Summary of Logical Operation

Logical Operation	Mean Score (x#)	Level of Understanding
Logical multiplication	14.69	Sufficient
Compensation	13.83	Sufficient
Classification	10.82	Sufficient
Ratio and proportional thinking	10.51	Sufficient
Seriation	10.15	Sufficient
Probability thinking	6.3	Insufficient
Correlational thinking	8.93	Insufficient

The results revealed that in general, the respondents showed sufficient understanding in all the seven logical operations of Piaget with a global mean score of 10.74. Rank one in the seven logical operation as the highest achieved score with sufficient level of understanding was the logical multiplication (x# = 14.69). This meant that the respondents were able to demonstrate or perform the usual standard logical operations expected of them particularly in operations of multiplication relating to, involving, or being in accordance to logic. This was followed by compensation, the counter balancing, making or supplying appropriate equivalence, as the second highly achieved logical operations (x# = 13.83) with sufficient level of understanding. The third was the classification with a mean score of 10.82 and level of understanding as sufficient. Moreover, respondents also showed sufficient understanding in ratio and proportional thinking (x# = 10.51) and seriation (x# = 10.15).

However, it was also revealed an alarming result as the respondents performed with insufficient understanding both in probability thinking (x# = 6.30) and correlational thinking (x# = 8.93). Probability thinking refers to the establishment of a logical relation statement such that evidence conforming to one conforms to the other to some degree (Piaget, 1950) while correlational thinking refers to the establishment of correlation or causal relationship. It may also refer to the presentation or setting forth so as to show relationships (Bruner, 1961). This means that in these two logical operations, the respondents, in general, just interpreted the problem correctly and made an overt and partial explanation of the solution of the problem.

The results conformed the results of Pagay (2008) in five logical operations namely: classification, seriation, logical multiplication, compensation and ratio and proportional thinking where the respondents performed with at least sufficient understanding in answering but not in probability thinking and correlational thinking.

However, the findings were in contrast with the results of Domingo (2018) and Gamit (2009) particularly in the said first five logical operations where both respondents of the two previous studies showed insufficient understanding.

Respondents' Category of Cognitive Skills

To address the third objective of this study, this portion presents the frequency and the percentage of the respondents who were categorized based on their cognitive skills achievement in Mathematic. The categorization of the respondents was proposed by Raven (1973). Student participants in general were in age range of 19-20 years old, which according to Piaget's theory of cognitive development were on their formal operational stage. Part of this study concurs with Piaget.

Table 3: Summary of Responses of Respondents of Cognitive Stage

Cognitive Stage	Number of Respondents	Percentage	Logical Operations
Formal Operational	52	59.09%	Complete understanding in all logical operations
Late Formal	3	3.41%	Complete understanding in all logical operations
Early Formal	49	55.68%	Insufficient understanding in probability thinking and correlational thinking
Late Concrete Operational	36	40.91%	Insufficient understanding in all logical operations

Table 4: For the Late Concrete Operational Respondents

Logical Operation	Mean Score (x#)	Level of Understanding
Logical multiplication	12.57	Sufficient
Compensation	12.28	Sufficient
Classification	10.86	Sufficient
Probability thinking	4.22	Insufficient
Correlational thinking	6.72	Insufficient
Ratio and proportional thinking	8.47	Insufficient
Seriation	8.72	Insufficient
Global Mean Score	9.13	Insufficient

Table 5: For the Early Formal Respondents

Logical Operation	Mean Score (x#)	Level of Understanding
Logical multiplication	16	Complete understanding
Compensation	14.71	Sufficient
Ratio and proportional thinking	11.61	Sufficient
Classification	11.22	Sufficient
Seriation	11.08	Sufficient
Probability thinking	7.29	Insufficient
Correlational thinking	9.96	Insufficient
Global Mean Score	11.7	Sufficient

Table 6: For the Late Formal Respondents

Logical Operation	Mean Score (x#)	Level of Understanding
Correlational thinking	18.67	Complete understanding
Compensation	18	Complete understanding
Logical multiplication	17.67	Complete understanding
Ratio and proportional thinking	17	Complete understanding
Probability thinking	15	Sufficient

Classification	13.33	Sufficient
Seriation	12	Sufficient

The data revealed that majority of the respondents (52 or 59.09%) were at the formal operational stage. Three respondents or 3.41 percent were at late formal stage which implied that these three elementary pre-service teachers, according to Leongson and Limjap (2003), fully and correctly solved almost all the logical operational problems. They had strong evidence of the attainment of logical thinking and reasoning pattern in mathematics at the formal level and clearly articulated their thought processes by giving correct solutions most of the time. Moreover, they were able to demonstrate a global understanding of the problem, employed a cognitive schema which facilitated the understanding of problem structure, chose and utilized the appropriate solution strategies, and successfully attained the correct answer.

Meanwhile, majority of the respondents (49 or 55.68%) were at the early formal stage of Piaget's Theory of Cognitive Development. This indicated that majority were able to make a great progress in the solutions, where problems on all logical operations were nearly solved, and whose solutions were correct but minor errors are committed on all of the items of the test. There were some evidences of the attainment of reasoning patterns in mathematics at the formal level. Their thinking processes were clearly manifested in the problem solution that they gave.

However, 36 or 40.91 percent of the respondents did not concur with Piaget. These 36 respondents were considered at the late concrete operational stages which age ranges from 7 to 11 years old. This revealed that these students showed understanding of the problems given on each logical operation by the representations and early attempted that they made to solve all the problems. There were major inconsistencies with their solutions and answers. Thus, they were able to pursue the sub-goal but failed to arrive at the main goal of the problem (Lengson&Limjap, 2003).

As the 36 or 40.91 of the respondents were considered in the late concrete, they were able to show sufficient understanding in logical multiplication (x# = 12.57), compensation (x# = 12.28) and classification (x# = 10.86). Meanwhile, they performed insufficiently in probability thinking (x# = 4.22), correlational thinking (x# = 6.72), ratio and proportional thinking (x# = 8.47) and seriation (x# = 8.72). A global mean score of 9.13 suggested that this group of students performed all the logical operations with insufficient understanding.

Early formal students (n=49) answered the problems in logical multiplication (x# = 16.00) with complete understanding. They showed sufficient understanding in answering problems in compensation (x# = 14.71), ratio and proportional thinking (x# = 11.61), classification (x# = 11.22) and seriation (x# = 11.08). However, they had insufficient understanding in probability thinking (x# = 7.29) and correlational thinking (x# = 9.96). This group of students had sufficient understanding in solving the problems in the seven logical operations with a global mean score of 11.70.

The only three students who were considered in the late formal stage performed with complete understanding in correlational thinking (x# = 18.67), compensation (x# = 18.00), logical multiplication (x# = 17.67) and ratio and proportional thinking (x# =17.00). This meant that they had the capabilities and potentials regarded as beyond what were expected of them. They showed complete understanding of the essence and structural relations of data in the problem. Also, they exhibited this characteristic, they had the ability to understand and grasp fully the mathematical tasks presented to them and solved them with logical representations (Pagay, 2008). Meanwhile, they performed sufficiently in probability thinking (x# = 15.00), classification (x# = 13.33) and seriation (x# = 12.00). With these results, the three respondents committed minor mistakes and were expected to be able to deal and perform higher order of difficulty.

The results of this study negated the study of Domingo (2018), Decano (2017), Gamit (2010) and Leongson and Limjap (2003) where the result of their studies was alarming to reveal that most of their respondents were considered at the concrete operational stage. This study apparently sounded positive since majority (52 or 59.09%) were able to perform the logical operations. This concured with Pagay (2008) where 12 out of 12 of his respondents were at the formal stage of cognitive development. Generally, the respondents of this study proved that the expected stage as students in higher level matched with Piaget's theory.

Socio-Demographic Characteristics and Cognitive Skills Achievement in Mathematics

To address the fourth objective of the study, the socio-demographic characteristics such as sex, type of high school graduated from, place of residence, engagement in recreational activities, educational attainment of the father, educational attainment of the mother and monthly income and the cognitive skills achievement in mathematics were gathered and analyzed to determine and explain differences in cognitive skills achievement using the aforementioned variables.

It shows that the data from the statistical treatment utilized for the purpose of this objective.

In this result, a series of analysis of variance (ANOVA) was utilized to determine the significant difference in cognitive skills achievement between group of respondents according to sex, type of high school graduated

from, place of residence, educational attainment of the father, educational of the mother, and monthly family income.

Engagement in Recreational Activities and Differences in Cognitive Skills Achievement

Table 7: Summary of the Results for each of the Group

Group	Cognitive Skills Achievement in Mathematics	Mean (x#)	Standard Deviation (SD)
Engaged in Recreational Activities	Higher	79.09	15.44
Not Engaged in Recreational Activities	Lower	-	-

Using ANOVA, the results showed that there was a significant difference in cognitive skills achievement in Mathematics between group of respondents according to their engagement in recreational activities (F(“,$%) = 7.090, p < 0.01, η’ = 0.08) indicating that respondents who were engaged (x# = 79.09, SD = 15.44) in recreational activities tend to have higher cognitive skills achievement in Mathematics than those who were not engaged. This result was consonant with the article written by Street et al. (2007), people who participate in sports clubs and organized recreational activity enjoy better mental health and cognitive ability, are more alert, more resilient against the stresses of modern living and promote intellectual advancement. Participation in recreational groups and socially supported physical activity is shown to reduce stress, anxiety and depression, and reduce symptoms of Alzheimer’s disease. In addition, Wang et al. (2012) showed that leisure activities have positive impact on cognition and dementia. This implies that the group of respondents who are engaged in recreational activities had better mind and cognitive skills and ability since they maintain to have a good mental health.

Educational Attainment of the Mother and Differences in Cognitive Skills Achievement

Table 8: Summary of the Results on Educational Attainment

Educational Attainment	Cognitive Skills Achievement in Mathematics	Mean (x#)	Standard Deviation (SD)
Graduate Studies	Higher	89.75	12.47
Elementary Level	Lower	70.33	9.07
Secondary Level	Lower	69.32	9.91
College Level	Lower	76.11	12.47

ANOVA was also utilized to determine the significant difference in cognitive skills achievement in Mathematics between group of respondents according to the educational attainment of their mother. Results of the ANOVA showed that there was a significant main effect of educational attainment of the mother to cognitive skills achievement in mathematics (F((,$)) = 11.83, p < 0.001, η' = 0.30). A follow-up Post-
Hoc analysis using Tukey HSD test revealed that respondents whose mothers earned graduate studies (x# = 89.75, SD = 12.47) had cognitive skills achievement in mathematics that was significantly higher than those respondents whose mother’s educational attainment was elementary level (x# = 70.33, SD = 9.07), secondary level (x# = 69.32, SD = 9.91) and college level (x# = 76.11, SD = 12.47). Meanwhile, the cognitive skills achievement of those whose educational attainment of mothers were elementary, secondary and college level were comparable based on the respondents’ scores.
This result conformed with Araza (2017) and Farooq et al. (2011). It was found out that the educational attainment of the parents particularly the mother could explain differences in cognitive skills achievement. As said by Wadley (2014), the amount of education one attains can predict children’s success in reading and math. This may be added to the notion that it is the mother who is in touch when it comes to supervising her children particularly in school. Parents with higher level of education could be role models for their children to perform well in mathematics (Andaya, 2014). This finding was also supported by Araza (2017) where he found out that college students’ math achievement was related to their mother’s educational attainment. However, the results contradicted the findings of Hayali (2013) and Escarlos and Tan (2017) where they documented that educational attainment of both mother and father was not related to academic performance.

Monthly Family Income and Differences in Cognitive Skills Achievement

Table 9: Summary of the Results on Monthly Family Income

Monthly Family Income	Cognitive Skills Achievement in Mathematics	Mean (x#)	Standard Deviation (SD)
High	Higher	94.8	21.14
Middle	Comparable	79.55	14.11
Low	Lower	72.07	11.25

To determine the significant difference in cognitive skills achievement in Mathematics between group of respondents according to monthly family income, ANOVA was also utilized. Results of the ANOVA showed that there was a significant main effect of monthly family income to cognitive skills achievement in Mathematics (F(',$*) = 9.198, p < 0.001, η' = 0.18). A follow-up Post-Hoc analysis using Tukey HSD test revealed that respondents who have high monthly family income (x# = 94.80, SD = 21.14) were significantly higher than those who have low monthly family income (x# = 72.07, SD = 11.25) and middle monthly family income (x# =
79.55, SD = 14.11) in terms of cognitive skills achievements in Mathematics. Meanwhile, the cognitive skills achievement in Mathematics of respondents who have low monthly family income and middle family income were statistically comparable.

This result was consonant with the study of Kirkup (2008) where he revealed that students with high level of socio-economic status performed better than the middle-class students and the middle-class students performed better than the students with low level of SES. More so, to Farooq et al. (2011) where he found out that socioeconomic status had a significant effect on students' overall academic achievement as well as achievement in Mathematics. The results implied that having a high monthly family income could affect cognitive skills achievement positively. This can be added to the notion that in highly income-generated family, children were given a chance and were provided by educationally rich and stimulating setting for the development of cognitive skills of the children. However, it contrasted the findings of Escarlos and Tan (2017) and Alver (2005) where they found that monthly family income and academic performance were insignificantly related.

Sex, Type of High School Graduated From, Place of Residency, Educational Attainment of the Father and Differences in Cognitive Skills Achievement

Table 10: Summary of Results of the Analysis

Variable	Main Effect (F-value)	p-value
Sex	0.092	> 0.05
Type of High School Graduated	0.358	> 0.05
Place of Residency	0.294	>= 0.650
Educational Attainment of Father	-	-

A series of ANOVA was conducted to determine the differences in cognitive skills achievement in mathematics when the respondents are grouped according to their sex, type of high school graduated from, place of residency and educational attainment of the father. The results revealed that sex (F(",$%) = 0.092, p > 0.05), type of high school graduated from (F(",$%) = 0.358, p > 0.05), place of 0.05), and educational attainment of the father (F((,$)) residency (F(",$%) = 0.294, p >= 0.650, p > 0.05) do not have significant main effect to cognitive skills achievement in Mathematics.

The analysis showed significant differences, thus, the null hypothesis that the there is no significant difference in cognitive skills achievement in Mathematics between group of respondents according to socio-demographic characteristics was rejected for engagement in recreational activities, educational attainment of the mother and monthly family income but accepted for sex, type of high school graduated from, place of residency and educational attainment of the father.

Predictors of Cognitive Skills Achievement in Mathematics

To address the fifth objective of the study, a multiple linear regression analysis was used to determine the predictors of cognitive skills achievement in mathematics based on sex, type of high school graduated from, place of residency, engagement in recreational activities, educational attainment of the father, educational attainment of the mother and monthly income. The results in Table 2 showed that a significant regression equation was found, R' = .37, Adjusted R' = .15, F(+,")) = 6.724, p < .001. Respondents' predicted cognitive skills achievement in Mathematics was equal to 51.63 – 5.20 (Engagement of Recreational Activities) + 7.23

(Educational Attainment of the Mother) + 5.84 (Monthly Family Income) where engagement in recreational activities was coded as 1=engaged, 2=not engaged, educational attainment was coded as 1=elementary, 2=secondary, 3=college, 4=graduate studies and monthly family income was coded as 1=low, 2=middle, 3=high. Respondents' cognitive skills achievement in Mathematics increased by 7.23 for every level of educational attainment of their mother, increased by 5.84 for each level of monthly family income and respondents who were engaged in recreational activities tended to be 5.20 higher than those who were not engaged. The three variables were significant predictors of cognitive skills achievement in mathematics.

Table 11: Multiple regression analysis for variables predicting the cognitive skills achievement in mathematics

PREDICTORS	Unstandardized Coefficients		Standardized Coefficients	t- value	p-value
	B	Std. Error	Beta		
Sex	4.34	9.08	.13	1.44	.153
Type of High School Graduated From	-2.40	3.01	-.08	-.83	.409
Place of Residency	1.97	3.12	.06	.63	.529
Engagement in Recreational Activities	-5.20	2.59	-.19	-2.01	.048
Educational Attainment of the Father	-1.12	1.85	-.06	-.61	.547
Educational Attainment of the Mother	7.23	1.67	.43	4.33	.000
Monthly Family Income	5.84	2.46	.25	2.37	.020
Note: Multiple R = .609 R^2=.37	Adjusted R^2=.15		F(7,124)=6.724		p=.000

The results presented in regression analysis, in consort with the previous results of analysis in the difference of cognitive skills achievement in Mathematics between groups of respondents based on their socio-demographic characteristics, could serve as an avenue to forecast the cognitive skills achievement in mathematics based on the three significant predictors. This would also allow the curriculum planners to encourage and make the students engage in recreational activities for its various positive effects on mental health and cognition as presented by Street et al. (2007) and Wang et al. (2012).

The analysis showed significant predictors, thus, the null hypothesis that the socio-demographic characteristics did not significantly predict the respondents' cognitive skills achievement in mathematics was rejected for engagement in recreational activities, educational attainment of the mother and monthly family income but was accepted for sex, type of high school graduated from, place of residency and educational attainment of the father.

CONCLUSION AND FUTURE WORKS

Conclusions

Most of the respondents particularly those who were taking Bachelor of Elementary Education were females. Majority of college education students were products of public high school and most were living in rural areas. Moreover, majority of the respondents were engaged in recreational activities and almost half of the parents earned high school level for educational attainment. Lastly, majority of the respondents belonged to families with low monthly family income.

Elementary pre-service teachers showed sufficient understanding in most of the seven logical operations and insufficient to some. However, they showed insufficient understanding in probability thinking and correlational thinking. These insufficiencies in other logical operations were attributed to their misconceptions on some mathematical terms, misinterpretation of the problems, poor comprehension skills, poor problem solving skills and poor performance in mathematics in general.

The cognitive skills achievement of majority of elementary pre-service teachers can be considered as formal. However, this result is still alarming for these group of students who would be deployed to teach the young learners. Higher percentage or ideally, all of them are expected in the late formal where the cognitive skills are performed with mastery as they will transfer knowledge and teach skills. In the results, students who were in concrete operational stage did not satisfy Piaget's logical operations as manifested in their ability to solve mathematical problems in the TLO in math. College mathematics and science instructors/professors may no longer assume that all fourth-year education students are already in the formal operational stage of cognitive development. This implies that professors must be aware that students may not be able to solve average to complex mathematics problems. Mastery of the cognitive skills is highly expected since it is needed to fulfill the twin goals of mathematics education in the K to 12 Curriculum.

According to the findings of the study, participation in leisure activities has a positive impact on the development of cognitive skills and mathematics performance among pupils. This research suggests that

engaging in recreational activities, which promote critical thinking and general physical and mental well-being, can help boost cognitive capacities.

Furthermore, the mother's educational status was revealed to have a considerable influence on cognitive skill achievement. This shows that adolescents with higher educational levels in their mothers likely to perform better in terms of cognitive skills. This finding emphasizes the significance of parental education in molding students' academic outcomes, particularly in mathematics.

Additionally, the study found that higher monthly family income was related to higher cognitive skill attainment and mathematics performance. This means that having a higher income level gives you better access to learning resources and a conducive learning environment, which in turn helps you grow and improve your cognitive skills in mathematics.

Taken together, the findings show that participation in recreational activities, mother's educational attainment, and high monthly family income are all important predictors of cognitive skills accomplishment in mathematics. These predictors can be used to anticipate elementary pre-service teachers' cognitive skill success, underlining the necessity of incorporating socio-demographic aspects in understanding and fostering children' cognitive growth in mathematics.

Future Works

1. Other socio-demographic and academic-related characteristics of the respondents are suggested to be observed to establish data for describing the students in a broader perspective and study their effects and contributions to their cognitive skills achievement.
2. Since students were found out to have insufficient understanding in some logical thoughts, mathematics teachers need to create a learning environment, develop teaching strategies and engage students in various learning materials that develop logical mathematical processes and promote cognitive skills.
3. Teachers need to align their instruction with the cognitive demands and cognitive levels of their students. Teachers in basic education should focus on the cognitive development of the learners since their cognitive skills and logical thinking skills are starting to develop in this stage. Since one of the major findings was the effect of engagement in recreational activities, teachers must encourage students to get engaged in various recreational activities.
4. Learning is best achieved when the teacher uses variety of teaching strategies and assessment tools, thus, there is a need for teachers to employ learning activities that focus on the development of students' thinking skills. Curriculum planners may revisit the mathematics curriculum and include the cognitive demand of the learners in developing exercises and activities. This study also suggests to promote easy access in different leaning materials and environment that promote learning and the inclusion of their parents in the academic development of the students.
5. Mathematics educators and educators of other disciplines should take the findings of this study seriously and conduct further studies on learner's cognitive development. The researcher recommends other researchers to conduct study on cognitive development of learners. They are highly encouraged to conduct researches in cognitive skills achievement that may improve cognitive skills using experimental research design.

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