

# **Logical Intelligence as Correlates of Academic Achievement in Advanced Algebra of Fourth Year High School Students**

**ROAR A. CALLAMAN**

ORCID No. 0000-0002-5027-3571

roarpatrick@gmail.com

F. Bustamante National High School

Davao City, Philippines

## **ABSTRACT**

Mathematics serves as the basis of modern innovations, discoveries and research studies. Students nowadays tend not to apply the concepts of Mathematics in the solution of meaningful problems since they were bombarded with the different factors affecting their academic achievement in mathematics. This study was conducted to determine the relationship between intellectual and non-intellectual factors and the academic achievement of students in advanced algebra. The descriptive - correlational method was used to determine the relationship between the achievement test in advanced algebra and the intellectual and non-intellectual factors which include logical intelligence, family income, number of years spent in school of the head of the family, time allotted in studying mathematics and interest in mathematics. Cluster Sampling Design was used as sampling design; that is, 217 fourth-year high school students of F. Bustamante National High School, School Year 2011-2012 were taken as respondents. Pearson Product Coefficient of Correlation was used to determine the relationship between the variables. While the logical intelligence of senior students was satisfactory, relationship with the academic achievement of students

was established in the findings at 0.05 level of significance, specifically in the domains of understanding, applying, analyzing and evaluating.

**Keywords** - Mathematics Education, logical intelligence, academic achievement, advanced algebra, fourth year high school students, descriptive-correlational method, Davao City, Philippines

## INTRODUCTION

The Trends in International Mathematics and Science Study (TIMSS) determine the performance of students in mathematics and science on their final year of secondary high school. The test for all students included general knowledge in Mathematics and Science. Students who were enrolled in advanced courses were given specialized assessment. It can be noted on the result of TIMSS test for the U.S. 12th graders, that students performed below the 21-country international mean on general knowledge in mathematics and science (NCES 1998). It was also observed in the 2003 result of the Trends in International Mathematics and Science Study (TIMSS) that Philippines ranked third from the bottom which gained a mean score of 358 which is below the international average of 495. It simply implies that there was a deterioration in the numerical and qualitative skills of students.

Despite all these, an alarming remark of Filipino students reveals that they only excel in knowledge acquisition but considerably below average in lessons requiring higher order thinking skills (HOTS). This unlucky state is evident in student's performance on surveys conducted in the national and international setting about science and mathematics competencies.

The study of Leongson and Limjap (2003) provided that even at the college level, certain logical operations are not fully developed. It also shows that 50% of the college students of Balaga Polytechnic State College have not fully understood the concept of ratio and proportion.

Mathematics education is geared towards the development of both the teachers and the students (Hidalgo 1995). With this fact, there is a need to identify the factors which will help both the teachers and the students to maximize their performance in mathematics in all levels may it be in elementary, secondary or tertiary.

Comparing the old National Secondary Achievement Test (NSAT) tests for high school seniors in the 1990s with the last NSAT in 2004, proficiency in English

has improved marginally though Science and Math worsened. In Mathematics, high school seniors have the most difficulty in using formulae to solve problems or to calculate results. The ability to manipulate numbers and equations (e.g. algebra) is weak. The ability to think conceptually and spatially (i.e. geometry and trigonometry) is even weaker. Problem solving using mathematical concepts and established logic and equations are poor.

In the local scenario, specifically in the Division of Davao City, Francisco Bustamante National High School (FBNHS) ranked 37 out of 69 secondary public schools in the city and had a result of “Low Mastery” in Mathematics in the 2011 Result of National Achievement Test.

Claiming to the belief that the quality of education is measured by students’ achievement, every educator feels the imperative need to determine the relationship between the intellectual and non-intellectual factors to the academic achievement of student in advanced algebra.

## FRAMEWORK

Gestalt’s views of learning have been integrated in order to come up with *cognitive theories*. Cognitive theories view outside behavior in order to explain the brain-based learning. The concept of how human memory works to promote learning has been studied and considered by the cognitivists. The theory on cognitive flexibility recommends that learners grasp the nature of complexity more readily by being presented with multiple representations of the same information in different contexts. Learners develop their mental scaffolding necessary for considering novel applications within their knowledge domain. By confronting the learner with multiple representations of case-events, the cognitive flexibility hypertext fosters the development of knowledge-transfer skills. This theory has a unique emphasis on dealing with complex problem-solving situations (higher-order thinking skills) (Graddy 2006).

Academic performance is related to Multiple Intelligence theory of Gardner (1999) which implies that the pluralistic view of the individuals mind, recognizing many different facets of cognition and acknowledging that every individual have different cognitive strengths and contrasting cognitive styles.

The complex view of intelligence states that some finite set of mental processes gives rise to a full range of intelligent human activities. Christison (1996) asserted that this intelligence was most completely realized in the process of solving problems in real-life situations. Considering these benefits the theory has given

to educators, it was then the duty of the researcher to modify and reflect on his practices in order to meet the present needs of his learners.

Based on the theory of multiple intelligence, which was formulated by Gardner, the researcher conceptualized that the logical intelligence is one of the factors that could affect academic performance of students in advanced algebra.

Piaget's concept of logical thinking (Inhelder and Piaget, 1958 and 1964), has been studied and popularly utilized extensively for the purpose of science and mathematics teaching at all levels. Piaget underscores the need to understand the concept of logical operations. He defines these operations in terms of the actions exhibited in thought as well as in actual execution. These operations are conserved, invariant, and reversible. He claims that learners need to use these operations for them to get to the structure of knowledge and its transformation.

Ercikan et al., (2005) claimed that students' mathematics achievement and participation in advanced mathematics courses can be affected by different independent variables that include both student personal and environmental variables. Among these variables are students' attitudes toward mathematics, self-expectations and the expectations of parents, teachers, and friends, students' confidence in mathematics, parents' highest level of education attained, home support for learning.

Intellective Factors are factors inclined with the intelligence of every individual. Logical intelligence is considered as intellective factors since it is one of the intelligences possessed by every individual according to the theory of Multiple Intelligence of Gardner.

Logical/mathematical intelligence is the power of reasoning whether deductively or inductively. It also uses and identifies intellectual models and links. It is relevant to people who probe into different problems and issue and try to a scientific conclusion (Gardner, 1999).

The other independent variable is the non-intellective factors which include the following: family income, which denotes to profits and takings of the students' whole family; number of years in school of the head of the family, which refers to the educational success of the head of the family; family size, which refers to the number of members in the family; interest in mathematics; their attitudes in dealing the math subject and time allocated in studying mathematics in a week.

The dependent variable of the study is the academic achievement in advanced algebra in terms of the different domains for learning in the New Blooms' Taxonomy.

## OBJECTIVES OF THE STUDY

The purpose of the study is to determine the relationship between intellectual and non-intellectual factors and the academic achievement of fourth-year high school in advanced algebra. Specifically, the study aims to determine the level of logical intelligence of the students; determine the profile of students in the following non-intellectual factors in terms of family income, number of years in school of the head of the family, family size, time allotted in studying mathematics, interest in mathematics; determine the level of academic achievement of students in advanced algebra in terms of remembering, understanding, applying, analyzing, evaluating, creating, overall achievement; determine the significant relationship between logical intelligence and the academic achievement of students in advanced algebra; and determine the relationship between non-intellectual factors and academic achievement in advanced algebra.

## METHODOLOGY

### Research Design

The descriptive-correlational method of research was used in this study. Descriptive method will give the quantitative and qualitative description of the general level of the students on the different factors presented in this study as well as their level of achievement test result. The achievement test in terms of remembering, understanding, applying, analysing, evaluating and creating was correlated with the independent variables which include Logical Intelligence, Family Income, Number of years spent in school of the Head of the Family, Family Size, and Time Allocated in Studying Mathematics and Interest in Mathematics. Positive relationship denotes that sets of scores increase or decrease together. Negative relationship indicates that as set of score increases, the other set of score decreases.

### Research Instrument

The following were the research instruments used in the study:

1. **Logical Intelligence Test.** The logical intelligence test questionnaire was adopted from Dr. Luca Govoni (2006). The content validity was established upon the consultation of experts. The test instrument underwent re-pilot testing, and its internal consistency reliability index was 0.656.

**2. The Personal Data Questionnaire.** The personal data questionnaire for students is a fill in the blank type of eliciting information about the following non-intellective factors: family income, which mean to the total monthly income of the family members; number of years spent in school of the head of the family which refers to the total number of years spent in school of the head of the family from elementary to tertiary level, family size, which refers to the total number of members in the family; time allocated in studying mathematics is the total number of minutes spent by the students in studying mathematics in a week; and interest in mathematics, which refers to the perceived level of interest by the students.

The construct validity of the questionnaire was being established upon the consultation of experts, and its reliability was 0.724 after computing its reliability index using the SPSS 14.0 software.

**3. Advanced Algebra Achievement Test.** This test is for the senior students used to determine the students' achievement in Advanced Algebra. Table of specification was constructed. The test was developed upon consultation and validation of the experts. This test underwent several processes to accommodate the suggestions of experts. From 50 item test, 5 items were deleted to established its internal consistency reliability.

### **Respondents of the Study**

The respondent of this study was the 217 fourth-year students who were currently enrolled in the school year 2011-2012 of Francisco Bustamante National High School, Tibungco Davao City, Philippines. The researcher obtained an informed consent from the respondents in compliance to research ethics protocol.

### **Data Gathering Procedure**

The researcher sought first the permission from school administrators to conduct a study by sending formal letters. After the approval to conduct the study, the questionnaires for personal data, logical intelligence and advanced algebra achievement test were administered by the researcher with the help of the class moderators of the respondents. The questionnaires were gathered and collated. The data gathered from the respondents were carefully analyzed on what statistical tools should be used in order to answer the problem statement. The data analysis has been possible with the help of a statistician. Data were statistically processed and converted to tabular presentations. Tables were analyzed, interpreted and given educational implications.

## Data Analysis

The data gathered were summarized, translated and analyzed using the following different statistical tools: mean, standard deviation, range, frequency, percentage, Pearson r Correlation. The statistical computation in this study was done using the SPSS 14.0 software.

All interpretation of the data output was based at  $\alpha = 0.05$  level of significance.

## RESULTS AND DISCUSSION

### The Level of Logical Intelligence of the Fourth-Year Students

Table 1. Descriptive statistics of the scores of students in logical intelligence

Scores	Description	Frequency	Percent
25-30	Very High	5	2.3
19-24	High	27	12.4
13-18	Moderate	101	46.5
7-12	Low	79	36.4
0-6	Very Low	5	2.3
Total		217	100
Mean	14.14	Moderate	
Standard Deviation	4.382		

The frequency distribution of the scores of the students in logical intelligence test is presented in Table 1. It was observed that the highest score is 27, which was very high while the lowest score was 6, which means very low. It is also showed that the result obtained a mean of 14.44 indicating that the respondents have a moderate level of logical intelligence. This result implies that the respondents answered 40-60% of the items correctly.

### The Students' Profile on the Non-intellective Factors

Table 2. Non-intellective profile of the senior students

	Family Income	Number of Years spent in school of the head of the family	Family Size	Time allotted in Studying	Interest in Mathematics
Mean	8565.67	9.71	6	39.33	3.03
Standard Deviation	5610.81	2.66	1.985	43.603	0.796

**Family Income.** It can be observed that it has an average monthly income of \$194.63. The result implied that most of the students' family monthly income was below the poverty line (National Statistics Coordination Board).

**Number of Years Spent in School of the Head of the Family.** The Table showed that the average number of years spent in school of the head of the family of the respondents was 9.71 which means that most of the students' head of the family were high school graduate.

**Family Size.** In the same Table, the mean family size of the respondent was observed to have 6 members.

**Time Allotted in Studying.** The students' mean time allotted (minutes) in studying mathematics was shown to be 39.33 per week. The implication is that most of the students spare almost 40 minutes a week in studying mathematics subject.

**Interest in Mathematics.** In the same Table, the mean score of 3.03 for their interest in the mathematics subject was shown which means that the students' perceived interest in mathematics was moderate.

### Level of Academic Achievement of Students in Advanced Algebra

Table 3. Level of academic achievement in Blooms' Taxonomy domain

Domain	Mean	SD	Level
Remembering	7.203	1.393	High
Understanding	6.567	3.253	Moderate
Applying	2.953	2.110	Low
Analyzing	1.576	1.505	Low
Evaluating	0.788	0.817	Low
Creating	0.327	0.470	Low
<b>Overall Achievement</b>	<b>19.447</b>	<b>6.724</b>	<b>Moderate</b>

As presented in Table 3, the overall mean score of the students in the achievement test in advanced algebra was 19.447 which denote moderate level of

achievement. This means that the students answered 40-60% of the items in the achievement test in advanced algebra.

The remembering domain of the students in their achievement test in advanced algebra has a mean score of 7.203 which was on a high level. This score implies that the students have a high capacity in recalling learned information.

The only domain which achieved a moderate level was understanding domain with a mean score of 6.567. This result indicates that the students have a moderate level in comprehending the meaning, translation, interpolation, and interpretation of instructions and problems and stating a problem in one's own words.

On the other hand, majority of the students have poor achievement in applying, analyzing, evaluating and creating. The findings denote that the students have a low capability in using the concept in a new scenario, apply what was learned, distinguish between facts and inferences, make judgments about the value of ideas, build a structure or pattern from diverse elements, put components together to form a whole, and create a new meaning. Furthermore, this finding implies that most of the students' higher order thinking skills (HOTS) on these domains were not fully developed.

### Relationship between the Logical Intelligence and Academic Achievement

Table 4. Correlation of logical intelligence and Blooms' Taxonomy domain of the academic achievement in advanced algebra

	<b>Domains</b>	<b>Pearson r</b>	P value	<b>Consequence</b>
<b>Intellective Factor</b>	Understanding	0.354**	0	Ho is rejected
	Applying	0.384**	0	Ho is rejected
	Analyzing	0.387**	0	Ho is rejected
	Evaluating	0.135*	0.047	Ho is rejected
	Over-all	0.425**	0	Ho is rejected

It can be seen in Table 4 that the Pearson r value of logical intelligence and the academic achievement in terms of understanding, applying, analyzing and evaluating domain were 0.354, 0.384, 0.387 and 0.135 respectively, with their computed p-value less than 0.05. Findings, therefore, suggest the rejection of the null hypothesis which states that there is no significant relationship between the logical intelligence and achievement test in terms of understanding, applying,

analyzing and evaluating domains. This result indicates that as the score of students will increase from these 4 domains, their logical test score will also increase. Moreover, if the learners' rating in logical intelligence increases then they are capable of stating the problem in their own words. They can apply ideas in a new scenario and separate concepts into parts so that its structure may be understood. These learners can differentiate between facts and inferences and can make judgments.

On the other hand, the computed Pearson r value of remembering domain and creating domain were 0.097 and 0.126 respectively, with the computed p-value 0.156 and 0.063 both greater than 0.05. This result suggests the acceptance of the null hypothesis, which says that there is no significant association among logical intelligences and academic achievement test in terms of remembering and creating domain.

Furthermore, the same table showed that the over-all achievement scores of the students in advance algebra and logical intelligence test has a positive correlation with a Pearson r value of 0.425, with computed p-value of 0 that is less than 0.05. Therefore, the null hypothesis was rejected. This implies that an increase in the scores of the students in logical intelligence, their achievement test score will also increase. This result could be supported by the study of Ghazi et al. (2011) who concluded that there was a positive correlation between perceived logical-mathematical intelligence and academic achievement of the students. Moreover, the study strengthened the study of McMahon et al. (2004) who revealed that the higher the scores of students on Logical-Mathematical Intelligence were more likely have a high score on achievement in reading.

**Relationship Between Non-intellective Factors and Academic Achievement**

Among the non-intellective factors in the study, only the years spent in school of the head of the family has a significant correlation with the academic achievement of students.

Table 5. Correlation between years spent in school by the head of the family and academic achievement

<b>Non-Intellective Factor</b>	<b>Domains</b>	<b>Pearson R</b>	<b>P value</b>	<b>Consequence</b>
Years Spent in school	Evaluating	-0.152*	0.025	Ho is rejected
	<b>Over-all</b>	<b>0.033</b>	<b>0.63</b>	<b>Ho is accepted</b>

On the other hand, for the number of years of the head of the family in school, it resulted to negative correlation equal to  $-0.152$  which means that the higher the number of years of the head of the family spent in schooling, the lower will be the score of their children in synthesizing. However, it can be noted that the relationship between these two variables is small. With this, the null hypothesis which states that there is no significant relationship between the number of years spent by the head of the family and academic achievement in terms of synthesizing was rejected. This result could be supported by the study of Shaw and Brown (1957) who concluded that there was no significant relationship between parents' educational attainment and the achievement of students.

The instrument used in obtaining the students' interest in mathematics uses Likert-Scale. It would be better if this is revised into rubrics. Also, we must consider other non-intellective factors in the study.

## CONCLUSIONS

1. There was a significant relationship between logical intelligence and academic achievement in terms of understanding, applying, analysing, evaluating and overall achievement.
2. There was a negative significant relationship between the number of years spent in school by the head of the family and the academic achievement of students in terms of evaluating.

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