LOGICAL-MATHEMATICAL INTELLIGENCE AND MATHEMATICS ACHIEVEMENT OF GRADE 9 STUDENTS IN SALIN TOWNSHIP

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Abstract

The aim of this study was to investigate the logical-mathematical intelligence and mathematics achievement of Grade 9 students in Salin Township, Magway Region. A total of 700 Grade 9 students (350 males and 350 females) from Salin Township in 2018- 2019 Academic Years were randomly selected. The descriptive research design and quantitative survey method were taken. Logical-mathematical Intelligence was measured by using Logical-mathematical Intelligence Questionnaire based on Multiple Intelligences Developmental Assessment Scales (MIDAS) developed by Shearer, C.B (1994). This questionnaire consists of 15 items (Cronbach's Alpha = 0.589) with four factors. Mathematics Achievement test was constructed by researcher through item analysis process to examine the Mathematics achievement of Grade 9 students. In the data analysis, the descriptive statistics, independent sample *t* test, One-way ANOVA, Pearson Product-moment Correlation and Simultaneous Multiple Regression were utilized in this research. The result of independent sample *t* test by gender showed that there was no significant difference in logical-mathematical intelligence but there was significant difference in mathematics achievement which showed that the female students were better than male students. And, the result of independent sample *t* test by school locality, which showed that the urban students had better performance than the rural students in logical-mathematical intelligence and mathematics achievement. The result of ANOVA showed that there were significant differences among father education level and mother education level in logical-mathematical intelligence. But, there were no significant differences among father education level and mother education level in mathematics achievement. The result of Pearson product-moment correlation showed that logical-mathematical intelligence was significant positively correlated with mathematics achievement. Besides, logical-mathematical intelligence can significantly predict mathematics achievement in accordance with the result of regression analysis.

Keywords: *Logical-mathematical Intelligence, Mathematics Achievement, Item Analysis*

Introduction

In Today's Knowledge Age, Education is the most powerful weapon to change the world. It can be said that if there is no education regarded as the greatest constructive force in empowering people in their productive work, there will be no any progress or development anywhere. So, school period is the most sensitive period of people lives; hence, it is important to identify and improve their intelligent level which are one of the most essential key factors in learning environments that effect and shape through their long lives in accordance with the rapidly changing age.

Intelligence is one of the main pillars of well-built education for lives. The word "Intelligence" derives from the Latin verb "intelligere" which derives from inter-legere meaning to "pick out" or discern. Different psychologists defined "intelligence" from various points of view. David Wechler (1944) tries to provide somewhat comprehensive definition "intelligence" is the aggregate or global capacity of an individual to act purposefully, to think rationally, and to deal effectively with his environment (cited in Mangal, 2002). Howard Gardner (1983) defined

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intelligence broadly as "the capacity to solve problems or to create products that are valued within one or more cultural setting" (cited in Brualdi, 1996).

Theory of Gardner's Multiple Intelligence provides a more holistic and natural profile of human potential (cited in Gangadevi, 2014). The Theory of Multiple Intelligence was developed in 1983 by an American psychologist, Dr. Howard Gardner, Professor of Education at Harvard University.

According to Gardner, each individual has these intelligences: (1) Verbal/Linguistic Intelligence, (2) Logical/Mathematical Intelligence, (3) Spatial/Visual Intelligence, (4) Bodily/ Kinesthetic Intelligence, (5) Musical Intelligence, (6) Interpersonal Intelligence, (7) Intrapersonal Intelligence, (8) Naturalist Intelligence and (9) Existential Intelligence.

Howard Gardner identified Logical-mathematical as one of the "intelligences" that people have (cited in Moursund, 2004). Logical-mathematical intelligence consists of the capacity to analyze problems logically, carry out mathematical operations, and investigate issues scientifically. Gardner (1993) says it entails the ability to detect patterns, reason deductively and think logically (cited in Alviarez, 2015). Logical-mathematical intelligence is the ability to use abstraction, logics, and reasoning such as deductive and inductive in problem-solving, handling of objects scientifically, thinking concretely about those objects and formally of relations without objects, then showing the implications of an event (cited in Gudder, 2013).

Mathematics is becoming important in our increasingly technological world. Mathematics is the branch of science concerned with number, quantity, and space, as abstract concepts. And, mathematics also plays a vital role as mathematics is a backbone of the students to achieve and developed the skill in reasoning and thinking level. But, all over the global, mathematics has been viewed as a challenging subject by a significant portion of learners. Science the beginning of recorded history, mathematics discovery has been at the forefront of every civilized society, and in even the most complex a society, the more complex the mathematics needs (cited in Kalsia, 2017).

In the present educational system, more and more importance is given to the achievement of students in their academic and related activities. The educationalists believes that study of mathematics helps in the mental and intellectual development, disciplines, simplicity, accuracy, certain and verification of results, originality and reasoning. Mathematics achievement refers to not only to obtaining excellent marks in the greater level final examination but it also refers to the attainment of the mathematical ability and skills. Children's poor performance and maths avoidance has remained a significant challenge for the education community since several decades. There are numerous personal and environmental factors that can influence students' achievement in mathematics (cited in Kalsia, 2017).

So, there is a need to study logical-mathematical intelligence and mathematics achievement of Grade 9 students in Myanmar. Students need supporting them to boost their mathematics achievement. I hope that to boost mathematics achievement, need to higher logical-mathematical intelligence.

Research Questions

1. Are there any significant differences in logical-mathematical intelligence and mathematics achievement by gender?
2. Are there any significant differences in logical-mathematical intelligence and mathematics achievement by school locality?

3. Are there any significant differences in logical-mathematical intelligence and mathematics achievement by father education?
4. Are there any significant differences in logical-mathematical intelligence and mathematics achievement by mother education?
5. Is there any significant relationship between logical-mathematical intelligence and mathematics achievement?

Scope of the Study

This research study was geographically limited to Grade 9 Students at 2018-2019 Academic Years in Salin Township, Magway Region. In this study, researcher will use Multiple Intelligence Developmental Assessment Scales (MIDAS) to investigate logical- mathematical intelligence which consists of four factors: Strategy Games, Everyday Skill with Math, Everyday Problem Solving and School Math, which is developed by Shearer,

C.B. (1994) including qualitative review by subject experts. For assessing the students' mathematics achievement, mathematics achievement test based on Grade 9 Mathematics Textbook was developed by the researcher.

Definition of Key Terms

Intelligence: The capacity to solve problems or to create products that are valued within one or more cultural setting (Gardner, 1983).

Logical-mathematical Intelligence: The ability to think conceptually and abstractly, and capacity to discern logical and numerical patterns (Gardner, 1983).

Achievement: Achievement is defined as a product which can be measured by means of achievement tests. (Van den Aardweg, 1988)

Mathematics Achievement: Mathematical achievement refers to understanding of mathematical concepts, application of knowledge to new situations and logical reasoning as involved in interpretation of data, interpretation of missing links, etc (Kulkarni 1970).

Review of Related Literature

Intelligence as a concept has been understood in different ways by different psychologists and has, therefore, a wide variety of definitions. Throndike (1914) defined intelligence as "the power of good responses from the point of view of truth or fact". Terman (1921) stated as "an individual is intelligent in the proportion that he is able to carry on abstract thinking". Jean Piaget (1952) mentioned that "intelligence is the ability to adapt to one's surroundings".

Gardner (1983) defined logical-mathematical intelligence as the ability to think conceptually and abstractly, and capacity to discern logical and numerical patterns. Armstrong (1994) defined logical-mathematical intelligence is the capacity to use numbers effectively (e.g., as a mathematician, tax accountant, or statistician) and to reason well (e.g., as a scientist, computer programmer, or logician). This intelligence includes sensitivity to logical patterns and relationships, statements and propositions (if- then, cause-effect), functions, and other related abstractions. The kinds of processes used in the service of logical-mathematical intelligence include categorization, classification, inference, generalization, calculation, and hypothesis testing (cited in Armstrong, 2008).

Logical-mathematical intelligence can be trained and worked without having to be good at math. This training can help the students to do more effectively in many activities of daily living. The thinking that underlies logical reasoning, for example, determining in a sequence the missing elements and the relationships between them, can help the students solve everyday problems from a different perspective (cited in Rodriquez, 2017).

Mathematics Achievement

The world today, which leans more and more heavily on science and technology, demands more and more mathematical knowledge on the part of more and more people and the world of tomorrow will make still greater demands on a person to be 'well educated' in the technological society of today, and as such he or she should have some degree of mathematical literacy. Mathematics provides language to sciences and is imperative for thought, logical reasoning and progress. It releases the mind and also gives individuals an appraisal of the intellectual abilities by pointing towards course of improvement. It is the basis of all sciences and technology and therefore of all human endeavors. Mathematics is a subject which provides basis directly or indirectly to almost all subjects. A bank of mathematical brain would help the rational and scientific growth of any society. All scientific education is based on mathematics. Its neglect means to remain ignorant about all the advancements. The knowledge of mathematics is indispensable for a wide variety of professions. No other subject has larger application than mathematics. It is the most significant instrument for understanding and exploring our scientific, economic and social world. In every field of human endeavor the importance of mathematics cannot be underestimated. Because of the wide importance of mathematics and the way in which it is advancing at an amazing rate, it has a persistent influence on our everyday lives and contributes to the wealth of the country (cited in Kaur, 2017).

Educators and parents have long considered the role gender plays in the development of attitude toward mathematics and in mathematics achievement. Gender, socioeconomic status, and parents' educational level are various demographic factors which have been predictors of math achievement.

Recent studies in mathematics achievement highlight the importance of the classroom, teacher and school as factors affecting performance in the subject. Most the differences in student achievement in the United States and Australia were due to compositional and organizational factors, not so much on teacher factor. Hill and Rowe (1998) affirmed that teachers have major effect on student achievement. Teachers' quality contributes a lot in the effectiveness of the school hence quality instruction produces high achievement. Demographic factors such as gender, parents' educational attainment and socioeconomic status are also found to be factors in students' achievement (cited in Andaya, 2014).

Curriculum, instructional strategies, math teacher competency, school context, and facilities are other significant factors in teaching and learning mathematics. The mathematics curriculum contains specific subject matter and instructional design principles to enable students to develop logical and mathematical skills needed to understand fundamental mathematical concepts. Designing an instruction based on a curriculum that is in harmony with instructional design can scaffold students learning and promote their achievement in mathematics. Instructional strategies and methods are important for the achievement of the students. School safety and facilities, temperature of the class, features of the school buildings and crowdedness

of school were also reported in influence the achievement of students. These results point out that attention should be given to school context and facilities to improve the math achievement of students (cited in Andaya, 2014).

Role of Item Analysis

Item represents the test. All the things of a test depend on items. The importance of item analysis is given below:

1. There can be little doubt that item analysis is a vitally important operation in the development of a new test and one that should invariably be carried out unless special circumstances.
2. Both the validity and reliability of any test depend ultimately on the characteristics of its items. High reliability and validity can be built into a test in advance through item analysis.
3. Test can be improved through the selection, substitution or revision of items.
4. Item analysis makes it possible to shorten a test and at the same time to increase its validity and reliability.

There are some reasons why item analysis should be conducted. By doing item analysis,

- It indicates which items are difficult, easy or moderate.
- It indicates the ability of the item to discriminate between inferior and superior students.
- It indicates why a particular item in the test has not functioned effectively so that it can be modified.
- It indicates effectiveness of destructors in multiple choice items.

Methodology

Sampling

The participants were used for this research from Grade 9 students in Salin Township at 2018-2019 Academic Years.

Table 1 Number of Students from School locality in Salin Township

School	Number of Students		
	Male	**Female**	**Total**
Rural	175	175	350
Urban	175	175	350

Research Design and Method

Descriptive research design and quantitative survey method were used in the present study.

Instrumentation

Logical-mathematical Intelligence Questionnaire

Logical-mathematical Intelligence Questionnaire that based on Multiple Intelligences Developmental Assessment Scales (MIDAS) developed by Shearer, C.B (1994) was adapted to Myanmar Version to examine the logical-mathematical intelligence of students. This

questionnaire consists of 15 items with four factors; Strategy Game which consists of 4 items, Everyday Skill with Math which consists of 5 items, Everyday Problem Solving which consists of 3 items and School Math which consists of 3 items. This is a 4 point Liket scale questionnaire from 1(strongly disagree) to 4 (strongly agree). The Cronbach's alpha reliability coefficient of the logical-mathematical intelligence was .589, which indicating that the instrument can be considered as a reliable tool to be used for the purpose of this study.

Mathematics Achievement Test

In this study, mathematics achievement test was constructed under the direction and guidance of experts in educational test and measurement field, experts in methodology and experts in mathematics departments with the reference of Grade 9 Mathematics Text Book. The type of test items is multiple choice items with four alternatives.

First, nine chapters from the content of Grade 9 Mathematics (1) Text Book and three chapters from the content of Grade 9 Mathematics (2) Text Book were selected and multiple-choice (MC) were constructed systematically according to the rules of construction. Second, constructed the table of specifications, and then expert review was conducted for face validity and content validity by 6 experts in the Department of Mathematics (SUOE), Department of Mathematics (SGU), Department of Mathematics (YUOE), Department of Methodology (YUOE) and Senior Assistant Teacher in No (2) B.E.H.S Sagaing.

Then, revisions in wording and length of items were made according to supervision and editorial review of these experts. And then, mathematics achievement test was administered to 70 students from No. (2) B.E.H.S, Sagaing for pilot testing. After administering, item analysis was done by using Test Analysis Program (TAP). The result can be seen in Table 2.

Table 2 Result of Item Analysis in Pilot Testing

No.	DI	DP	No.	DI	DP	No.	DI	DP
Item 1	0.80	0.50	Item 21	0.40	0.53	Item 41	0.23	0.06
Item 2	0.14	0.10	Item 22	0.43	0.91	Item 42	0.39	-0.12
Item 3	0.64	0.63	Item 23	0.31	0.34	Item 43	0.27	0.43
Item 4	0.70	0.35	Item 24	0.69	0.22	Item 44	0.37	0.44
Item 5	0.83	0.22	Item 25	0.69	0.36	Item 45	0.01	0.00
Item 6	0.44	0.82	Item 26	0.53	0.68	Item 46	0.57	0.26
Item 7	0.31	0.58	Item 27	0.64	0.73	Item 47	0.40	0.35
Item 8	0.59	0.59	Item 28	0.59	0.26	Item 48	0.71	0.08
Item 9	0.60	0.77	Item 29	0.46	0.77	Item 49	0.60	0.36
Item 10	0.50	0.86	Item 30	0.49	0.58	Item 50	0.33	0.02
Item 11	0.60	0.45	Item 31	0.40	0.35	Item 51	0.31	-0.04
Item 12	0.56	0.77	Item 32	0.44	0.82	Item 52	0.56	0.49
Item 13	0.56	0.77	Item33	0.44	0.58	Item 53	0.33	0.34
Item 14	0.66	0.64	Item 34	0.10	-0.09	Item 54	0.31	0.58
Item 15	0.59	0.59	Item 35	0.37	0.30	Item 55	0.61	0.26
Item 16	0.37	0.39	Item 36	0.36	0.48	Item 56	0.46	0.16
Item 17	0.56	0.63	Item 37	0.60	0.17	Item 57	0.03	0.48
Item 18	0.70	0.50	Item 38	0.40	0.21	Item 58	0.50	0.49
Item 19	0.49	0.82	Item 39	0.29	0.02	Item 59	0.13	-0.13
Item 20	0.53	0.44	Item 40	0.01	0.00	Item 60	0.41	0.63

According to item analysis, there were 13 items (2,34,37,39,40,41,42,45,48,50,51,57, 59) that were eliminated from the test by using the range of Tesring (2006). And then, the remaining 47 items were used as the mathematics achievement of Grade 9 students in main testing. To confirm the reliability of this test, the internal consistency (Cronbach's alpha) was computed and it was 0.901. After administering the main testing, item analysis was done. The result can be seen in Table 3.

Table 3 Result of Item Analysis in Main Testing

No.	DI	DP	No.	DI	DP	No.	DI	DP
Item 1	0.98	0.00	Item 21	0.51	0.65	Item 41	0.77	0.45
Item 2	0.76	0.36	Item 22	0.55	0.63	Item 42	0.61	0.56
Item 3	0.79	0.33	Item 23	0.81	0.35	Item 43	0.33	0.41
Item 4	0.88	0.27	Item 24	0.85	0.37	Item 44	0.72	0.50
Item 5	0.71	0.45	Item 25	0.70	0.60	Item 45	0.54	0.42
Item 6	0.49	0.51	Item 26	0.78	0.46	Item 46	0.65	0.59
Item 7	0.75	0.50	Item 27	0.69	0.55	Item 47	0.59	0.81
Item 8	0.84	0.39	Item 28	0.67	0.66			
Item 9	0.85	0.40	Item 29	0.65	0.55			
Item 10	0.88	0.30	Item 30	0.69	0.51			
Item 11	0.63	0.71	Item 31	0.61	0.74			
Item 12	0.79	0.36	Item 32	0.47	0.57			
Item 13	0.82	0.42	Item 33	0.59	0.63			
Item 14	0.76	0.53	Item 34	0.61	0.50			
Item 15	0.60	0.46	Item 35	0.66	0.58			
Item 16	0.80	0.35	Item 36	0.71	0.62			
Item 17	0.77	0.47	Item 37	0.71	0.61			
Item 18	0.70	0.56	Item 38	0.68	0.57			
Item 19	0.56	0.47	Item 39	0.58	0.71			
Item 20	0.65	0.65	Item 40	0.90	0.22			

According to item analysis, 17 items (1,2,3,4,8,9,10,12,13,14,16,17, 23, 24,26,40,41) were removed for the test by the rules of Tshering (2006). According to Tshering (2006), the rules for interpreting difficulty and discrimination index are described in Table 4.

Table 4 Suggested Rules for Difficulty Index and Discrimination Power

Difficulty Index	Discrimination Power	Item Evaluation
0.5 < DI < 0.6	DP 0.4	Good
0.25 < DI < 0.75	0.3 DP 0.39	Use with confidence
DI = 0.25 (or) DI = 0.75	0.2 DP 0.29	Revision-needed
DI < 0.25 (or) DI > 0.75	DP < 0.2	Do not use (reject)

After item analyzing, good and acceptable (30) items were chosen for this study. Thus, the mathematics achievement test can be regarded as it is highly reliable for use as the instrument.

Data Analysis and Findings

Mean Comparison of Logical-mathematical Intelligence by Gender Independent sample *t* test was conducted to compare the differences in logical- mathematical intelligence among male and female students. The result of *t* test was shown in Table 5.

Table 5 Results of Independent Sample t test for Logical-mathematical Intelligence by Gender

Variable	Gender	N	Mean	SD	*t*	*df*	*p*
Logical-mathematical Intelligence	Male	350	37.94	8.178	.392	698	.695
	Female	350	37.71	7.408			

According to Table 5, there was no significant difference in logical-mathematical intelligence by gender (t = 0.392, p = 0.695). Visual presentation for mean comparison of logical-mathematical intelligence by gender could be seen in Figure 1.

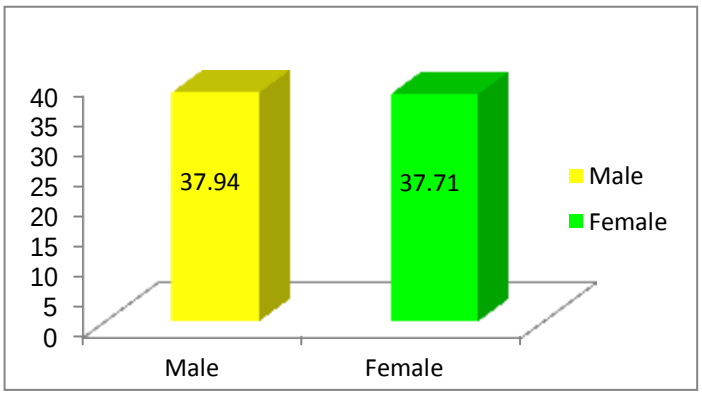

Figure 1 Mean Comparison of Logical-mathematical Intelligence by Gender

Furthermore, independent sample *t*-test was conducted to examine mean comparison on factors of Grade 9 student's logical-mathematical intelligence by gender. These results were shown in Table 6.

Table 6 Results of Independent Sample t test for Logical-mathematical Intelligence Factors by Gender

Factors	Gender	N	Mean	SD	t	df	p
Strategy Games	Male	350	10.01	2.495	7.535***	698	.000
	Female	350	8.70	2.092			
Everyday Skill with Math	Male	350	12.20	3.042	-1.272	698	.204
	Female	350	12.48	2.778			
Everyday Problem Solving	Male	350	8.04	2.160	-1.500	698	.134
	Female	350	8.28	2.123			
School Math	Male	350	7.69	2.241	-3.445**	698	.001
	Female	350	8.25	2.032			

**p 0.01, ***p 0.001

As presented in this table, male students were significantly higher than female students in strategy games at 0.001 level (t=7.535, p=0.000). But, female students were significantly higher than male students in School Math at 0.01 level (t=-3.4455, p=0.001). However, there was no significant difference in other factors.

The mean difference on factors of logical-mathematical intelligence between male and female students were compared in the following Figure 2.

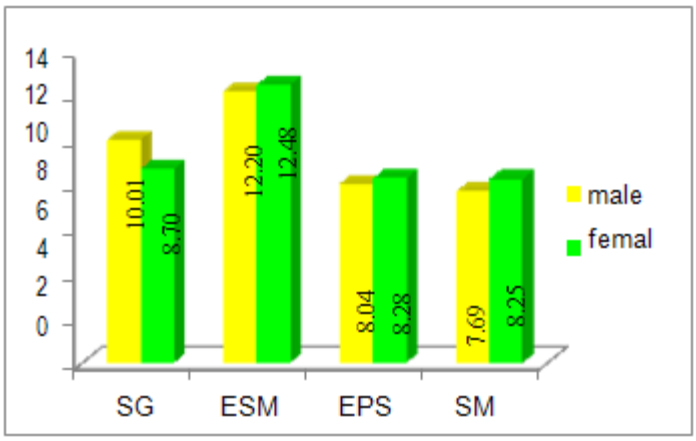

Figure 2 Mean Comparison of Logical-mathematical Intelligence Factors by Gender

Mean Comparison of Logical-Mathematical Intelligence by School Locality

In order to find out whether there was any significant difference in logical- mathematical intelligence by school locality, independent sample *t* test was conducted. The result was shown in Table 7.

Table 7 Result of Independent Sample t test for Logical-mathematical Intelligence by School Locality

Variable	School	N	Mean	SD	t	df	p
Logical-mathematical Intelligence	Rural	350	36.51	8.536	-4.516***	698	.000
	Urban	350	39.13	6.742			

****p* 0.001

According to Table 7, students who lived in urban were significantly higher than those who lived in rural in logical-mathematical intelligence at 0.001 level. To be clear, visual presentation was described in Figure 3.

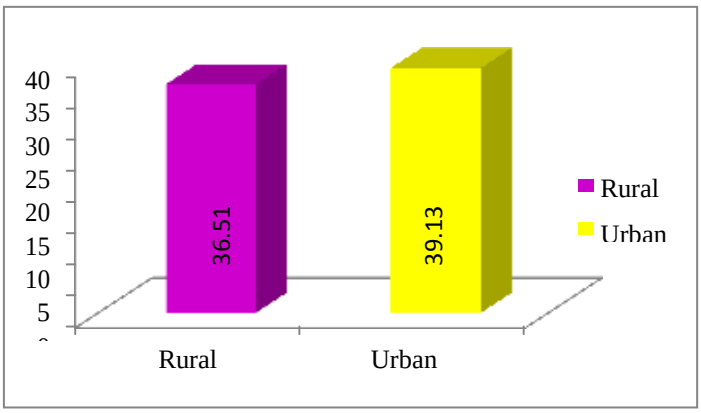

Figure 3 Mean Comparison of Logical-mathematical Intelligence by School Locality

To make more detailed investigation, the mean differences on all factors of logical- mathematical intelligence between rural and urban were examined see in Table 8.

Table 8 Results of Independent Sample t test for Logical-mathematical Intelligence Factors by School Locality

Factors	Gender	*N*	Mean	*SD*	*t*	*df*	*p*
Strategy Games	Rural	350	8.91	2.405	-5.063***	698	.000
	Urban	350	9.81	2.296			
veryday Skill with Math	Rural	350	11.90	3.059	-4.011***	698	.000
	Urban	350	12.77	2.696			
Everyday Problem Solving	Rural	350	7.96	2.329	-2.496*	698	.013
	Urban	350	8.36	1.923			
School Math	Rural	350	7.74	2.390	-2.766*	698	.006
	Urban	350	8.19	1.870			

*p 0.05, ***p 0.001

Table 8 showed that the students who lived in Urban were significantly higher than those who lived in Rural in Strategy Games and Everyday Skill with Math at 0.001 level. And, Everyday Problem Solving and School Math, students who lived in Urban were significantly higher than students who lived in Rural at 0.05 level. To be clear, the mean differences on all factors of logical-mathematical intelligence between rural and urban were compared with the chart see in Figure 4.

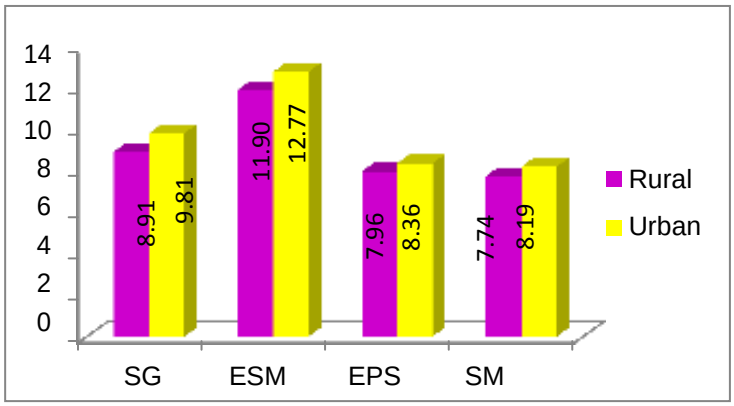

Figure 4 Mean Comparison of Factors on Logical-mathematical Intelligence by School Locality

The Differences in Logical-mathematical Intelligence among Father Education

To explore the differences in logical-mathematical intelligence among father education, one-way analysis of variance (ANOVA) was used. These results were shown in Table 9.

Table 9 Results of ANOVA for Logical-mathematical Intelligence by Father Education

Logical-mathematical Intelligence	Sum of Squares	*df*	Mean Squares	*F*	*p*
Between Groups	1383.879	3	461.293	7.808***	.000
Within Groups	41116.800	696	59.076		
Total	42500.679	699			

***p 0.001

Table 9 showed that there were significant differences in logical-mathematical intelligence of students among father education at 0.001 level. To get the specific information,

Post-Hoc test was conducted by Tukey HSD method. The results of Post- Hoc test were shown in Table 10.

Table 10 Results of Tukey HSD Test for Logical-mathematical Intelligence by Father Education

Variable	(I) Father Education	(J) Father Education	Mean Difference (I-J)	*p*
Logical-mathematical Intelligence	Primary	Middle	-1.909*	.034
		High	-3.567***	.000
		Graduated	-4.243**	.003
	Middle	Primary	1.909*	.034
		High	-1.658	.142
		Graduated	-2.335	.185
	High	Primary	3.567***	.000
		Middle	1.658	.142
		Graduated	-.676	.949
	Graduated	Primary	4.243**	.003
		Middle	2.335	.185
		High	.676	.949

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

According to Table 10, it was observed that the mean score of the logical- mathematical intelligence of Father Education in Middle, High and Graduated were significantly higher than that of Primary at 0.05, 0.01 and 0.001 level respectively. But, there was no significant difference in between High and Middle, between Graduated and Middle and between Graduated and High. Therefore, it can be interpreted that there was significant difference in logical-mathematical intelligence by Father Education.

The Differences in Logical-mathematical Intelligence among Mother Education

To investigate whether there were significant differences in logical-mathematical intelligence by mother education or not, one-way ANOVA was conducted. These results were shown in Table 11.

Table 11 Results of ANOVA for Logical-mathematical Intelligence by Mother Education

Logical-mathematical Intelligence	Sum of Squares	*df*	Mean Squares	*F*	*p*
Between Groups	968.667	3	322.889	5.411**	.001
Within Groups	41532.012	696	59.672		
Total	42500.679	699			

**$p < 0.01$

According to the ANOVA result in Table 11, there was significant difference among mother education on logical-mathematical intelligence. To be clearer, Post-Hoc test was conducted by Tukey HSD method. These results were shown in Table 12.

Table 12 Results of Tukey HSD Test for Logical-mathematical Intelligence by Mother Education

Variable	(I) Mother Education	(J) Mother Education	Mean Difference (I-J)	*p*
Logical-mathematical Intelligence	Primary	Middle	-1.125	.325
		High	-3.321**	.001
		Graduated	-2.664	.109
	Middle	Primary	1.125	.325
		High	-2.196	.065
		Graduated	-1.539	.559
	High	Primary	3.321**	.001
		Middle	2.196	.065
		Graduated	.657	.960
	Graduated	Primary	2.664	.109
		Middle	1.539	.559
		High	-.657	.960

**$p < 0.01$

According to Table 12, there was only significant difference in Mother Education between High and Primary at 0.01 level. But there was no significant difference in others.

Mean Comparison of Mathematics Achievement by Gender

To examine whether there was significant difference in mathematics achievement by gender or not, descriptive statistics was conducted. The result was shown in Table 13.

Table 13 Result of Independent Sample t test for Mathematics Achievement by Gender

Variable	Gender	*N*	Mean	*SD*	*t*	*df*	*p*
Mathematics Achievement	Male	350	16.88	6.635	-3.812***	698	.000
	Female	350	18.85	7.003			

***$p < 0.001$

Table 13 showed that the female students were significantly higher than the male students in mathematics achievement at 0.001 level. To be clear, visual presentation of mean comparison of mathematics achievement by gender could be seen in Figure 5.

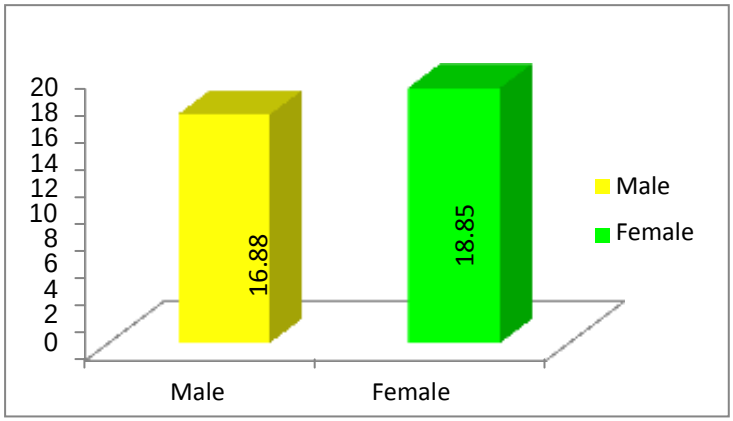

Figure 5 Mean Comparison of Mathematics Achievement by Gender

Mean Comparison of Mathematics Achievement by School Locality

To examine whether there was any significant difference in mathematics achievement by school locality, independent sample *t* test was conducted.

Table 14 Result of Independent Sample *t* test for Mathematics Achievement by School Locality

Variable	Gender	*N*	Mean	*SD*	*t*	*df*	*p*
Mathematics Achievement	Male	350	16.88	6.635	-3.812***	698	.000
	Female	350	18.85	7.003			

****p* < 0.001

Table 14 indicated that the students in urban schools were significantly higher than that of rural schools at 0.001 level. That is why the differences of some factors such as socio-economic status, received previous knowledge, practice of thinking, environmental condition and so on exist between urban and rural school students. To be clear, visual presentation could be seen in Figure 6.

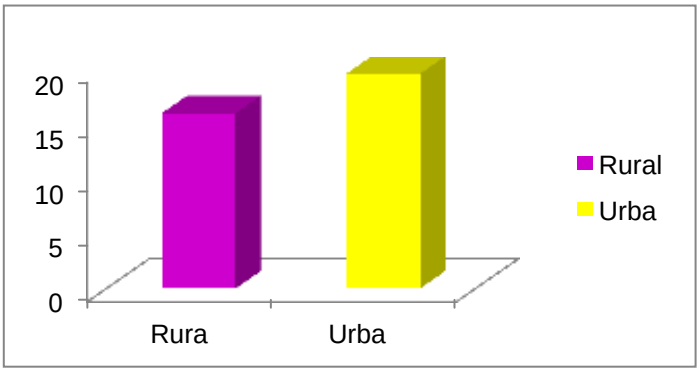

Figure 6 Mean Comparison of Mathematics Achievement by School Locality

The Differences in Mathematics Achievement among Father Education

To explore the differences in mathematics achievement among father education, one- way analysis of variance (ANOVA) was used. These results were shown in Table 15.

Table 15 Results of ANOVA for Mathematics Achievement by Father Education

Mathematics Achievement	Sum of Squares	*df*	Mean Squares	*F*	*p*
Between Groups	192.284	3	64.095	1.353	.256
Within Groups	32964.551	696	47.363		
Total	33156.834	699			

****p* 0.001

Table 15 showed that there were no significant differences in mathematics achievement of students among Father Education.

The Differences in Mathematics Achievement among Mother Education

To investigate whether there were significant differences in mathematics achievement by Mother Education or not, one-way ANOVA was conducted. These results were shown in Table 16.

Table 16 Results of ANOVA for Mathematics Achievement by Mother Education

Mathematics Achievement	Sum of Squares	*df*	Mean Squares	*F*	*p*
Between Groups	229.947	3	76.649	1.620	.183
Within Groups	32926.887	696	47.309		
Total	33156.834	699			

$^{**}p < 0.01$

According to the ANOVA result in Table 16, there were no significant differences among Mother Education on mathematics achievement.

Relationship between Logical-mathematical Intelligence and Mathematics Achievement of Grade 9 Students

In order to investigate the relationship between logical-mathematical intelligence and mathematics achievement of Grade 9 students, Pearson Product Moment Correlation coefficient was calculated. The result was shown in Table 17.

Table 17 Relationship between Logical-mathematical Intelligence and Mathematics Achievement

Variables	Correlation	Logical-mathematical Intelligence	Mathematics Achievement
Logical-mathematical Intelligence	**Pearson Correlation**	1	.460**
	Sig. (2-tailed)		.000
	N	700	700
Mathematics Achievement	**Pearson Correlation**	.460**	1
	Sig. (2-tailed)	.000	
	N	700	700

Note: ** Correlation is significant at the 0.01 level (2-tailed).

By the result of Table 17, there was a statistically significant positive relationship between four factors of logical-mathematical intelligence and mathematics achievement.

So, it can be interpreted that increase in logical-mathematical intelligence indicates that increase in mathematics achievement.

Conclusions, Discussions and Suggestions

The mean scores of male students were slightly higher than female students in logical- mathematical intelligence but according to the result of *t* test, there was no significant difference in the logical-mathematical intelligence by gender. This result agreed the previous research conducted by Shahzada, G. *et al.* (2014) that there was no significant difference among the Iranian males and females with respect to the types of intelligences they use. This result is also agreed with the study of Barnard & Olivarez (2007) showed that there were no significant differences in estimates of school valued intelligence as a total score composite of logical-mathematical and linguistic intelligences. This result may be possible because of the girls have the opportunities to keep abreast of the boys and the girl think more specifically before they do and act more systematically than the boys.

And, the result of mean comparison for logical-mathematical intelligence of Grade 9 students by school locality revealed that there were significant difference between students who lived in urban and those of rural. According to the result, urban students are higher than rural students in logical-mathematical intelligence. Therefore, it may be interpreted that the students from urban students had better performance than the students from rural in logical-mathematical concept problems.

According to research finding, there were significantly differences in logical-mathematical intelligence of Grade 9 students among Father Education. And, there was only significant difference in Mother Education between High and Primary at 0.01 level. But there was no significant difference in others. It may be possible that father and mother can be guided the students to improve the logical-mathematical intelligence by using several ways.

The result of this study mentioned that there was significant difference between the male and female students in mathematics achievement, and female students were better than the male students. This may be because of the facts that although the male students are bright in natural, most of female students concentrate more on the study than the male students and then the females students always ask for the suggestions from the teacher. Moreover, it may be due to the differences of attention and their own efforts on the study by gender. This result agreed with the research by Farooq, *et at*., (2011) that female students perform better than the male in mathematics subjects. The result also agreed the study of Lynn Shirley Freeguard (2014) who occurred that mathematics achievement of female students had better than that of male students. And, Endsley (1984), Wohlgehager (1992) Wang (2001) and Ganihar & Wajiha (2009) found that girls achieved significantly higher score in mathematics than that of boys.

By the effect of locality, the result of *t*-test showed that there was significant difference in mathematics achievement of students. The urban school students performed better than the rural school students on mathematics achievement in this study. This may be possible that some factors such as socio-economic status, received previous knowledge, practice of thinking, environmental condition, supporting form the family and so on exist between urban and rural school students. It is consistent the Rangappa (1993), Well (1996) and Singh & Singh (2007) studies, they found that urban students are better than rural students in mathematics achievement.

The correlation of this study showed that there was a significant positive correlation between logical-mathematical intelligence and mathematics achievement of Grade 9 students. And, the concept of mathematics achievement was mostly correlated only with the factors of school math in logical-mathematical intelligence. The result agreed with the study of Mohammad Niroo (2012) that there exists a significant relationship between the mathematical intelligence and students' mathematical functioning (cited in Niroo. 2012). This result also agreed that Siti, *et at*., (2013), he found in his study a significant positive correlation between logical-mathematical intelligence and academic achievement of the students.

Limitations of the Study

This study may have some limitations. Firstly, this study is limited by a sample size and it focused only on the selected students in one township (Salin Township, Magway Region). Therefore, the results of this study could not be generalized to the students in other townships of Magway Division, other regions and states of the country. Secondly, this study only determined the effect of Grade 9 students' logical-mathematical intelligence on their mathematics

achievement. So, the results might not be explained to the importance of logical-mathematical intelligence for other grades of state school students, for the grades of private schools students and also for the university students. Thirdly, the data in this study was cross-sectional and not longitudinal. Thus, these results may be change from time to time.

Suggestions for Further Research

According to the limitations of the study, the present study is conducted only in the Salin Township of Magway Region. Therefore, the results of this study are applied only to this township. Therefore, the future research should conduct in other Townships, Regions and States as the students in other places might have different logical- mathematical intelligence and mathematics achievement. So, it is necessary to future research to study the effect of logical-mathematical intelligence on the mathematics achievement in other Townships, Regions and States. The sample of the present study only comprised of the Grade 9 students in Salin Township. Thus, the future research should consider the students in different grade level in state schools and also should take into account the university students in different education level.

Moreover, future research should conduct as the qualitative study, using interview method, classroom observation or case study to study the students' logical-mathematical intelligence and mathematics achievement during academic year. And then, researches such as the relationship between logical-mathematical intelligence and science achievement should also be conducted because this intelligence is dominant in the fields of science and mathematics. Logical-mathematical intelligence plays an important role not only in students' future success but also in their future profession. Many researches about logical-mathematical intelligence are needed to conduct in Myanmar. It is needed to conduct more studies concerning the ways and activities to improve logical- mathematical intelligence and mathematics achievement.

In brief, by studying and learning about students' logical-mathematical intelligence and mathematics achievement, teachers can help their students to improve their logical- mathematical intelligence. Improving their logical-mathematical intelligence can create effective learners and subsequently can develop conducive learning environment. Hence, these studies truly contribute the field of educational psychology, especially educational guidance and measurement. Moreover, it can provide the educational system in Myanmar.

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