RELATIONSHIP BETWEEN LOGICAL-MATHEMATICAL INTELLIGENCE AND CREATIVE PROCESS OF MIDDLE SCHOOL STUDENTS

Khin Shun Lae Oo[1], Moe Moe Naing[2]

Abstract

The main purpose of this study was to investigate the relationship between the logical-mathematical intelligence and creative process of middle school students. Both quantitative and qualitative approaches were used in this study. A total of 804 Grade 6 and Grade 7 students from each district of Yangon Region participated as the sample of the study using stratified random sampling technique. For this study, Mathematical Intelligence test (α = 0.79)(Moe Moe Naing, 2008) and Creative Process Questionnaire (α = 0.66) developed by Whetton and Cameron (2011) and Chen, Runco, Lin and Chiou (2008) were used as instruments. After conducting the statistical analysis, the findings revealed that there was a significantly positive relationship between logical-mathematical intelligence and creative process (r=0.094). For logical-mathematical intelligence, there were significant differences as gender, grade level and region. Difference in creative process was found only in school. Female students were higher than male students in mathematical intelligence and Grade 7 students performed better than Grade 6 students in mathematical intelligence. As the result of ANOVA, students from all other schools outperformed on creative process than students from Yankin Teacher Training Centre. According to the interview results, most of the students (more than 57%) showed negative behaviors and characteristics, with no interest in Mathematics and they weren't enjoyable to participate in taking Mathematical Intelligence Test. And, most of the students (about 75%) showed that they had positive and desirable behaviors and motivation in creative process, even though there was no chance to create in real life situations.

Keyword: Logical-Mathematical Intelligence, Creativity, Creative Process

Introduction

No nation whether big or small can afford to overlook the importance of creativity in this age of competition. In our contemporary society in which individuals have to adjust constantly to new problems and find original solutions, creativity is indeed a feature that has become increasingly

1. Senior Assistant Teacher, Basic Education High School, Ah-Lann-Kone, Thonegwa Thonegwa Township, Yangon Region
2. Lecturer, Doctor, Department of Educational Psychology, Yangon University of Education

important. In order to solve any problem, knowledge should be applied in the right manner with the help of intelligence. According to the multiple intelligences theory (Gardner, 1983, 1999), logical-mathematical intelligence is activated in situations requiring problem solving or meeting a new challenge as well as situations requiring pattern discernment and recognition.

Creativity can be seen as the ability of man to establish new relationships to change reality. To change reality, the "creative" process is very important simply because it sdistinguishes normal thinking from psychotic one. Creative imaginations establish links between activities and the answers to multi-faceted questions (Pérez-Fabell & Campos, 2011). Logical-mathematical intelligence consists of the capacity to analyze problems logically, carry out mathematical operations, and investigate issues scientifically. In Howard Gardner's words, it entails the ability to detect patterns, reason deductively and think logically. This intelligence is also associated with scientific and mathematical thinking.

Modern society accords high prestige to logical-mathematical intelligence. So thus it can be said that a person's logical intelligence manifests itself through different activities and not through a particular activity (Gupta & Basu, 2006). This is also reflected in the systems of education. Entrance into most institutions of higher learning tends to rely heavily on performance on tests of Logical-mathematical intelligence. It is a fairly common place observation that most children are very creative. Rigorous studies involving tests of creative ability have determined that the processes of formal education and socialization into organizations over many years where the focus is predominantly on logical-mathematical intelligence robs students of the creative flame. Traditionally, researchers used to pay much more attention to the product of the creative process. In an educational situation, emphasis should be on the process.

Regularly, however the concept of creativity is related with intelligence, several early researchers (Andrews, 1930; Getzels & Jackson, 1962) have been shown the relation between creativity and intelligence has only modest correlations. Many research findings and observations have demonstrated that there is no positive correlation between creativity and intelligence. There has been debate in the psychological literature about

whether intelligence and creativity are part of the same process or represent distinct mental processes. According to Barron, Guilford or Wallach and Kogan, from the 1950s onwards, suggested that correlations between these concepts were low enough to justify treating them.

Such ambiguous findings arouse to find out whether the dimension of creativity, particularly creative process is related with logical-mathematical intelligence among the dimensions of multiple-intelligence. So, the researcher explored whether the factors influencing the creative process is related with the logical-mathematical intelligence. In terms of education and related areas, creativity and logical-mathematical intelligence are very much essential elements which are necessary for learning. If education strives to prepare children for a productive life in society, the educational system must accept responsibility for supporting and developing creativity and intelligence by motivating them.

Aim of the Study

The aim of this study was to explore the relationship between logical-mathematical intelligence and creative process of middle school students.

Definitions of the Key Terms

Logical-Mathematical Intelligence

According to Wily Walnut (2004), logical-mathematical intelligence is the capacity to reason, calculate, recognize patterns and handle logical thinking.

Creativity

According to Sternberg (2000), creativity is a skill that can be sharpened, and not due to natural ability.

Creative Process

Creative process denotes the actual experience of being creative. The Geneplore model presented by Finke, Ward and Smith (1992) describes two phases of framework; generation (building structure pre-inventive) and exploration (evaluating possible alternatives and choosing the best).

Characteristics of Creative Process; Chen, Runco (2008) and Yeh (2011) proposed that the characteristics of creative personality were curiosity, adventure, challenge, imagination, autonomy, self-control, strain, sensitivity, working hard, courage, self-confidence, perseverance, and optimism.

Abilities of Creative Process; Chen (2008) proposed sensitivity, fluency, flexibility, originality, and the elaboration of five creative abilities.

Barriers of Creative Process; Three levels of individual aspects, problems-solving, environment and organization were included in barriers.

Motivation of Creative Process; The intrinsic motivation was the most critical factor for creativity.

Review of Related Literature

What is Logical-Mathematical Intelligence?

Wily Walnut (2004) defined logical-mathematical intelligence as the capacity to reason, calculate, recognize patterns and handle logical thinking. Logical-Mathematical Intelligence traits:

- likes to count
- likes to be organized
- is very precise
- good at problem-solving
- recognizes patterns
- likes math games
- likes to experiment in a logical way
- orderly note-taking
- ability for abstract thinking
- likes computers

This intelligence is often associated with "scientific thinking." It makes it possible to calculate, quantify, consider propositions and hypotheses, and carry out complex mathematical operations. It is responsible for the various patterns of thinking used in daily lives, such as making lists, creating a schedule, setting priorities, and planning something for the future.

In Piaget's view, the logical-mathematical understanding constituted the primary focus from one's actions upon the world. The logical reasoning is the central factor of intelligence. The logical intelligence in the child early months is related to his moment to moment experience with them about 18 months After then, logical-mathematical skills begin with the handling of real objects and numerical operations gradually became internalized age. At the formal operational age, child use, words or symbols to stand for objects, he can work with hypothetical statements and explore logical relationships between statements (as cited in Gardner, 1983).

Logical-Mathematical Learner

If the students dominate upon mathematics intelligence, they think conceptually and abstractly and are able to see patterns and relationships that others often miss. They like to experiment, solve puzzles and other problems, ask cosmic questions, and think. They generally enjoy working with numbers and mathematical formulas and operations. They love the challenge of a complex problem to solve. They tend to be systematic and analytical, and they always have a logical rationale or argument for what they are doing or thinking. These students can be helped by encouraging them to develop fully and use their logical thought process (Lazear, 2004).

Due to these characteristics of logically and mathematically minded people, certain learning and studying techniques are more effective if they incorporate logic and order. For example, while studying or preparing something that needs to be memorized, making lists of key concepts or important aspects to remember is a very effective way for these learners to commit the material to memory. Additionally, searching for links and connections between different portions of the material will make it easier to understand for these learners; creating patterns is always a good idea if the brain tends to search for patterns and identify them easily. These techniques are particularly helpful when studying or learning material that doesn't involve mathematics or sciences; these topics can be more difficult to grasp and understand for logical mathematical learners.

Strategies to Assist the Logical-Mathematical Learner

Once students or children have been identified as logical-mathematical learners, it is important to assist them to develop strategies so that they can apply their learning strength to all areas of the curriculum. Armstrong (2001) described some key strategies as parents or teachers that can easily be applied to the classroom or home to assist a logical-mathematical learner.

- As a teacher, encourage opportunities to discuss numbers both inside and outside of mathematics and science. By doing this, the teacher will better engage highly logical learners; while the other students can see that mathematics does not just belong in a mathematics class.
- Use classification and categorization. Learners can do this in any class at school or at home. For example in a Science class, learners could be asked to put a certain examples under the heading of gas, liquid and solid.
- Bring Science terminology into any classroom or at home.
- Take part in Socratic questioning. Instead of talking to the learner, the teacher or parent serves as a questioner of student's points of view. Until the learner has reached an opinion, the teacher/parent participates in dialogues with them (as cited in Lazear, 2004).

Creativity

Creativity is the ability to describe the opportunity in every challenge. Creativity means having a choice in any situation (Zelinski 1994). Maimunah (2004) states that creativity starts with a creative thinking that generates ideas towards solving problems, making improvements, increasing productivity, enhancing effectiveness and adding values. Creativity is a collection or set of attitudes, and the driving ability of individuals to generate original and new ideas (Fisher 1990).

Creative individuals often elicit negative reactions from others by violating social norms and expectations. In a school setting, care should be taken to distinguish creative students from students who cause disturbances due to emotional or social problems. Creative students who find ways to engage others in their projects are likely to become outgoing and adopt leadership roles. Creative students who experience difficulties in this regard

are likely to engage in individual projects. In short, high creativity is compatible with both social and individualistic life styles; either outcome is healthy.

Creative Process

The creative process requires high levels of intelligence through personal judgment, flexibility and autonomy (Hall & Johnson, 2009). The mental and cognitive processes used in creative thought become unique as 'principles and elements of knowledge and insights that have not been connected before' (Ekvall, 1997, p. 195). Divergent thinking creates a flexible and unstructured platform for combining a vision of alternative realities with the practical aspects of established and current principles. This combining and reorganizing of derived knowledge and information to advance the thinking process and in turn to generate new ideas appears to be key to the creative process (Mumford, 2000).

Factors Influencing the Creative Process

The factors influencing creative process should be able to measure four variables comprising of characters, abilities, barriers, and motivation changed over time at difference levels following the teaching course in their further education of creative thinking. General education in Taiwan have emphasized on the creative-teaching and creative-thinking for almost ten years. The literature review focused on education areas was divided into four sections as characteristics, abilities, barriers, motivation for creativity.

For the characteristics of creativity, Chen (2008) proposed that the characteristics of creative personality were curiosity, adventure, challenge, and imagination. Runco (2008) provided autonomy, self-control, strain, sensitivity, and tolerance of being ambiguous, and paradox as temperaments of creativity. Yeh (2011) indicated working hard, courage, self-confidence, perseverance, and optimism as the characteristics of creators.

Regarding the abilities of creativity, Chen (2008) proposed sensitivity, fluency, flexibility, originality, and the elaboration of five creative abilities. For barriers to creativity, according to Chen, three levels of individual aspect, problems-solving, environment and organization were proposed. Regarding

the motivation for creativity, Lin and Chiou (2008) suggested that the intrinsic motivation was the most critical factor for creativity.

Human Brain Hemisphere

According to Leslie Wessman (2004), the logical-mathematical intelligence represents an intriguing mix of left and right-brain hemisphere processes. On the one hand, the ability to read and produce mathematical signs & symbols is a left-hemisphere processing mode. On the other hand, the ability to understand numerical relationships, to discern abstract patterns, and to comprehend logical-mathematical concepts and formulas is a right-hemisphere processing mode. The right hemisphere may be particularly good at supporting 'divergent' thinking and creativity more widely. In general, the hemispheres work together in harmony, although often the right hemisphere is underutilization. And really it is this hemisphere that is important for education and for fostering creativity. The challenge for teachers is how to find ways of fostering creativity that feeds the right brain as well as the left, for all children (as cited in Lazear, 2011).

Method and Procedures

Participants of the study

Pilot tests were administered to a sample of 40 students from Grade 6 and Grade 7 (21 males and 19 females) from BEHS, Pyin-htaung-kyaung, Thanlyin Township in Yangon Region to test whether the wording of the items, statements and instructions had comprehensiveness. For field testing, the sample consists of 804 of Grade 6 and Grade 7 students from eight high schools and middle schools located in Yangon Region. They were 389 boys and 415 girls.

Instrumentation

To examine the level of logical-mathematical intelligence of the middle school students, Mathematical Intelligence Test developed by Moe Moe Naing (2008) was used. To investigate the creative process in the students, Creative Process Questionnaire developed by David A. Whetton and Kim S. Cameron (2011) and Chen, Runco, Lin and Chiou (2008) were used.

This questionnaire consists of 56 items of factors influencing creative process included characters (23 items), abilities (11 items), barriers (11 items), and motivation (11 items). There are 10 negative items. For negative items, five-point likert scales (4= Strongly Disagree to 0= Strongly Agree) was used and for positive 46 items, the values are assigned as (0= Strongly Agree to 4 = Strongly Disagree) was used in this questionnaire. The internal consistency (Cronbach's Alpha) of the Creative Process Questionnaire was 0.66 and the internal consistency of the Mathematical Intelligence Test was 0.79.

In order to indicate the students' strengths and weaknesses in Mathematical Intelligence Test, the following scoring system was used.

Table 1: Scoring System for Mathematical Intelligence Test

Scoring Point	**Understanding**	**Solution**	**Explanation**
4	Complete Understanding	Correct Solution	Complete Explanation
2 or 3	Some Difficulty	Almost Correct	Incomplete Explanation
1	Poor Understanding	Attempt	Poor Explanation

Procedure

Permission to collect data was granted by the head masters of the participating high schools. The selected 389 male and 415 female Grade 6 and Grade 7 students from selected eight high and middle schools from each district in Yangon Region were tested by self-reported questionnaire to get the necessary data. The data obtained from the field tests were analyzed with the help of the SPSS statistical program (version 22) and the Microsoft Office Excel Program.

Data Analysis and Findings

Comparison of Logical-Mathematical Intelligence and Creative Process by Gender

According to the previous researches, there were gender differences in logical-mathematical intelligence and creative process. Therefore, to find out whether gender differences in logical-mathematical intelligence and creative process were or not, the following analysis was also conducted.

Comparison of Logical-Mathematical Intelligence by Gender

Descriptive analysis revealed the difference in mean and standard deviation of Logical-Mathematical Intelligence by gender. There was slight difference between the mean score of the male and female students in Logical-Mathematical Intelligence. To find out whether these differences were significant or not, the independent sample t-test was conducted. From the results of independent sample t-test, there were statistically significant differences with regard to gender.

Table 2: The Results of Independent Sample t-test of Logical-Mathematical Intelligence by Gender

Gender	N	Mean	Std. Deviation	t	Sig.(2-tailed)
Male	389	48.03	12.61	-3.451**	0.001
Female	415	51.01	11.89		

** The mean difference is significant at 0.01 level.

Comparison of Creative Process by Gender

To find out the differences in creative process between male and female students, descriptive analysis revealed the difference in means and standard deviation of creative process by gender. There was slight difference between the mean score of the male and female students in the subscales of creative process. The mean score of the male students was lower than that of the females in both subscales of character and abilities. But mean score of the male students was higher than that of the females in subscale of barriers and subscale of motivation was equally performed by gender. Visual presentation was given in figure 1.

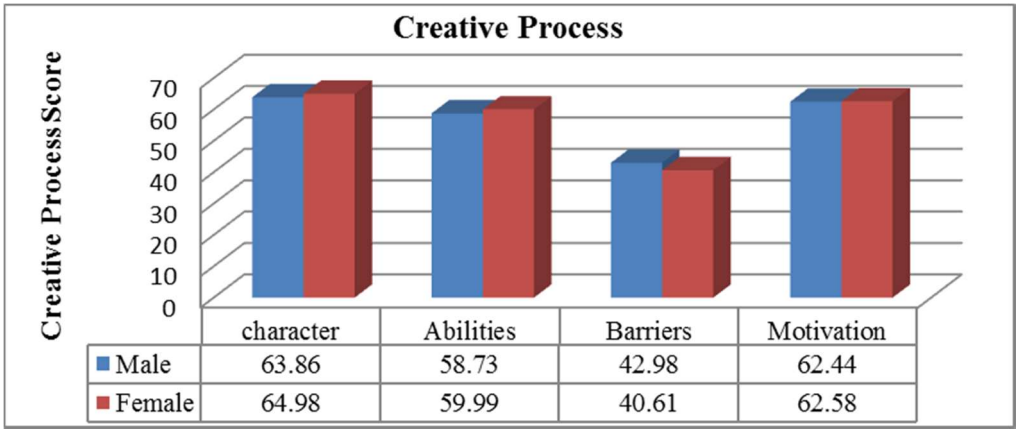

Figure 1: Mean Comparison of Creative Process by Gender

To find out whether these differences are significant or not, the independent t-test was conducted

Table 3: The Results of Independent Sample t-test for Subscales of Creative Process by Gender

Creative Process	t	df	Sig. (2-tailed)	Mean Difference
Character	.77	802	.444	.46
Abilities	-.77	802	.439	-.59
Barriers	.13	802	.894	.10
Motivation	.36	802	.720	.28

Therefore, according to the result of t-test, there was no significant difference for all the subscales of creative process by gender.

Comparison of Logical-Mathematical Intelligence and Creative Process by Grade

As the subjects of this study were selected from Grade 6 and Grade 7 students in Yangon Region, different educational levels might affect their grades in logical-mathematical intelligence and creative process.

Comparison of Logical-Mathematical Intelligence by Grade

To find out differences in logical-mathematical intelligence by grade, the mean and standard deviation of criteria in logical-mathematical intelligence between grades was statistically analyzed (See Table 4). To find out whether these differences are significant or not, the independent t-test was conducted.

Table 4: The Results of Independent Sample t-test of Logical-Mathematical Intelligence by Grade

Grade	N	Mean	Std. Deviation	t	Sig.(2-tailed)
Grade 6	384	46.82	12.92	-6.187***	0.000
Grade 7	420	56.08	11.19		

*** The mean difference is significant at 0.001 level.

From the results of Table 4, there were statistically significant difference with regard to grade. Grade 7 students were significantly higher than Grade 6 students in logical-mathematical intelligence.

Comparison of Students' Creative Process by Grade

To find out differences in creative process by grade, the mean and standard deviation of subscales of creative process between grades was statistically analyzed. Visual presentation is shown in figure 2.

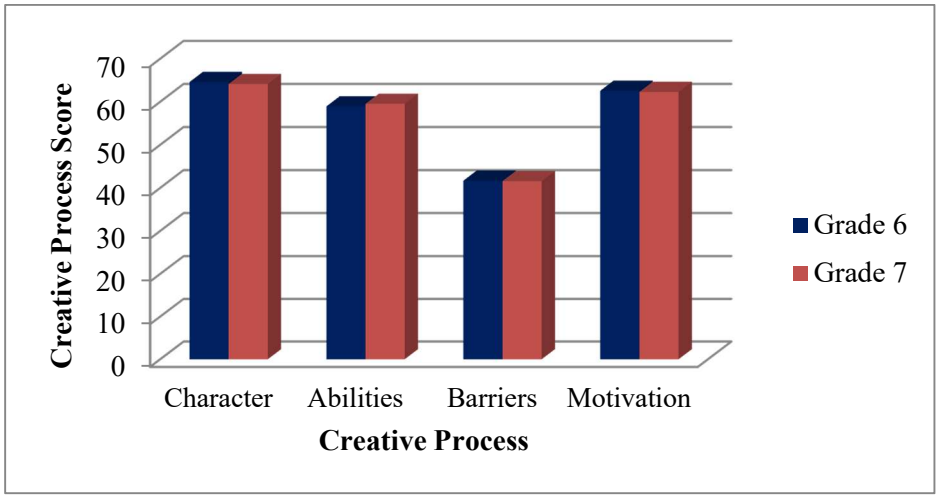

Figure 2: Mean Comparison of Creative Process by Grade

According to the results of the table 8, there was no significant difference between the mean score of the Grade 6 and Grade 7 students in the subscales of creative process. The mean scores of the Grade 6 students for all subscales were nearly equal to that of the Grade 7 students.

Comparison of Logical-Mathematical Intelligence and Creative Process among Districts

Although the sample of subjects was selected from almost the same age level, different geographical location may have different socioeconomic status. Accordingly, to find out the differences of logical-mathematical intelligence and creative process for four districts from Yangon Region, one way analysis of variance (ANOVA) was computed.

Table 5: ANOVA Results of Students' Logical-Mathematical Intelligence and Creative Process among Districts

Variables		Sum of Squares	df	Mean Square	F	Sig.
Logical-Mathematical Intelligence	Between Groups	2194.91	3	731.64	6.158***	.000
	Within Groups	95049.70	800	118.81		
	Total	97244.61	803			
Creative Process	Between Groups	369.15	3	123.05	2.140	.094
	Within Groups	46005.57	800	57.51		
	Total	46374.71	803			

*** The mean difference is significant at 0.001 level.

ANOVA results showed that there were significant differences in students' logical-mathematical intelligence among districts from Yangon Region. To obtain more detailed information, Post-Hoc test was executed by Tukey HSD method and this results showed that the students' logical-mathematical intelligence from West District were higher than that of East, South and North Districts and they were significantly different at 0.05 level.

Table 6: The Results of Tukey HSD Multiple Comparison for Students' Logical-Mathematical Intelligence among Districts

Dependent Variable	(I) Districts	(J) Districts	Mean Difference (I-J)	Std. Error	Sig.
	West	East	2.943*	1.07	.030
		South	3.332*	1.08	.011
		North	4.421*	1.09	.000

* The mean difference is significant at 0.05 level.

Comparison of Students' Logical-Mathematical Intelligence and Creative Process among Schools

Next, although the sample of subjects was selected from public schools with the same curriculum, teaching styles of their respective teachers might be difference. So, to find out the differences of students' logical-mathematical intelligence and creative process among schools from Yangon Region, one way analysis of variance (ANOVA) was computed. ANOVA results showed that there were significant differences in students' logical-mathematical intelligence among schools from Yangon Region at 0.05 and creative process at 0.001 level.

Table 7: ANOVA Results of Students' Logical-Mathematical Intelligence and Creative Process among Schools

Variables		Sum of Squares	df	Mean Square	F	Sig.
Logical-Mathematical Intelligence	Between Groups	2205.01	7	315.00	2.638	.011
	Within Groups	95039.60	796	119.40		
	Total	**97244.61**	**803**			
Creative Process	Between Groups	1608.85	7	229.84	4.087***	.000
	Within Groups	44765.86	796	56.24		
	Total	**46374.71**	**803**			

*** The mean difference is significant at 0.001 level.

To obtain more detailed information of a particular group, Post-Hoc test was executed by Tukey HSD method. (See Table 8)

Table 8: The Results of Tukey HSD Multiple Comparison for Students' Creative Process among Schools

Dependent Variable	(I) School	(J) School	Mean Difference (I-J)	Std. Error	Sig.
Creative Process	Yankin TTC	B.E.H.S(1) Thingangyun	-4.807*	1.05	.000
		B.E.H.S(2) Kamayut	-4.073*	1.04	.003
		B.E.H.S(2) Lanmataw	-4.449*	1.08	.001
		B.E.H.S(2) Thanlyin	-4.106*	1.06	.003
		B.E.H.S(1) Kyauktan	-3.448*	1.10	.039

* The mean difference is significant at 0.05 level.

The Results showed that students' creative process from Yankin TTC were lower than B.E.H.S(1) Thingangyun, B.E.H.S(2) Kamaryut, B.E.H.S(2) Lanmadaw, B.E.H.S(2) Thanlyin, and B.E.H.S(1) Kyauktan. So, it can be assumed that students from Yankin TTC may be more emphasis on memorization than other schools.

Relationship between Students' Logical-Mathematical Intelligence and Creative Process

Many research findings and observations have demonstrated that there is no positive correlation between creativity and intelligence. So, to find out the relationship between logical-mathematical intelligence and creative process of Myanmar Middle School Students from Yangon Region, the correlation coefficient was calculated. These results were summarized in below.

Table 9: Correlation between Logical-Mathematical Intelligence and Creative Process

		Creative Process
Logical-Mathematical Intelligence	Pearson Correlation	.094**
	Sig. (2-tailed)	.007

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

According to Table 9, there was significantly positive correlated between logical-mathematical intelligence and creative process at 0.01 significant level but the value of coefficient is very low. So, the following analysis was conducted whether the logical-mathematical intelligence is also related with the factors influencing the creative process.

Table 10: Correlation between Logical-Mathematical Intelligence and Factors influencing Creative Process

		Logical-Mathematical Intelligence
Character	Pearson Correlation	.114**
	Sig. (2-tailed)	.001
Abilities	Pearson Correlation	.106**
	Sig. (2-tailed)	.003

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

According to Table 10, the findings showed that there were positive correlations among logical-mathematical intelligence, character and abilities of (factors influencing creative process). So, it can be expected that students with high logical-mathematical intelligence could contribute to students' curiosity, challenge, imagination, sensitivity, fluency, flexibility and elaboration which were similar with the result proposed by Chen (2008).

The values of the correlation coefficients of logical-mathematical intelligence, creative process and factors influencing creative process would be low. It may be due to the fact that the ability to read and produce mathematical signs & symbols (logical-mathematical intelligence) is a left-

hemisphere processing mode and the right hemisphere may be particularly good at supporting 'divergent' thinking and creativity more widely.

Levels of Students' Logical-Mathematical Intelligence and Creative Process of Myanmar Middle School Students

According to the percentile analysis, students' logical-mathematical intelligence and creative process were categorized into high, middle and low groups.

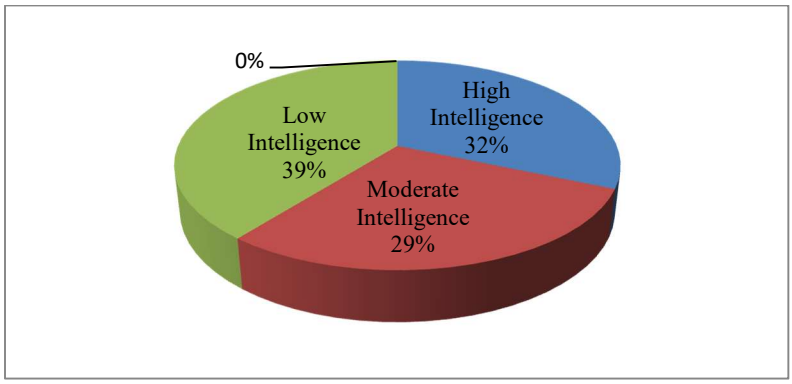

Figure 3: Level of Logical-Mathematical Intelligence of Middle School Students

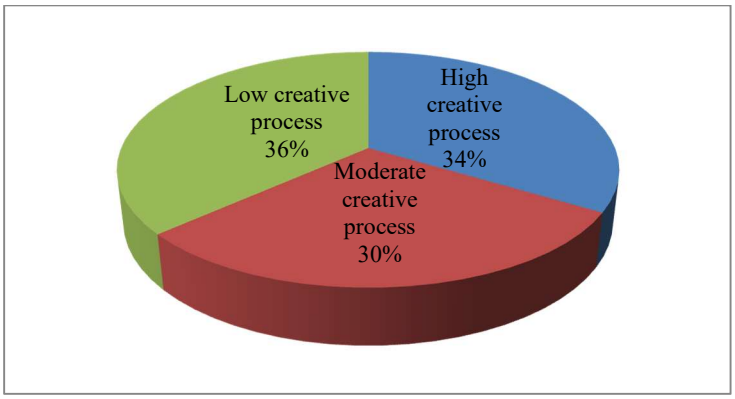

Figure 4: Level of Creative Process of Middle School Students

And then, to investigate the causes of being low correlated, Crosstabulation of mathematical intelligence and creative process were calculated.

Table 11: The Result of Crosstabulation by Level of Mathematical intelligence *Level of Creative Process

		Creative Process			Total
		High	**Middle**	**Low**	
Mathematic Intelligence	**High**	77	82	**94**	253
	Middle	99	59	85	243
	Low	**94**	68	146	308
Total		**270**	**209**	**325**	**804**

The results showed that students who had low mathematical intelligence were high creative and students who had high logical-mathematical intelligence were low creative. By these results, there was low correlation between these two concepts. This finding was conformable to authors such as Barron (2003), Guilford (1950) or Wallach & Kogan (1965) who suggested that scoring high on intelligence tests might demonstrate no signs of creativity where as individuals performing poorly in intelligence tests may sometimes create something very original.

Qualitative Study

According to the result of table 11, as the quantitative survey results showed that students who had low mathematical intelligence were found to be high creative whereas students who had high logical-mathematical intelligence were low creative. The results of qualitative study was conducted by interview with the participants in order to ensure the background ability of mathematics and creativity concepts. In this study, 19 students who had these conditions were chosen to collect the interview results. They were 8 students who had high logical-mathematical intelligence with low creative process and 11 students who had low mathematical intelligence with high creative process. The participants in this interview study were classified into eight categories according to their responses: the students of high groups who were interested in Mathematics and who were not; the students of low groups who were interested in Mathematics and who were not. Similarly, the students of high groups who were interested in creativity and who were not; the students of low groups who were interested in creativity and who were not.

For mathematics intelligence test item, 62.5% of high group and 27.27% of low group were interested in learning mathematics. From these results, most of the students in high group apparently had keen interest in mathematics. For creative process item, 75% of high group and 27.27% of low group were interested in creative process. So, most of the students in high group apparently had keen interest in creative activities.

One student of low intelligence group was not interested in mathematics so also his average score was 41% in test. This response proved in consonance of interview results and survey results. Consider the case of student a:

I don't want to participate in this activity because I'm interested in English.

So, I don't attempt to understand the problems especially in geometry,

I never get good marks in chapter end tests (13 February, 2017).

One student of high intelligence group was interested in mathematics so also his average score was 90% in test. This response also proved in consonance of interview results and survey results. Consider the case of student d:

> *I enjoy to participate in this activity because I'm interested in Mathematics. So, I attempt to understand the problems, I always get good marks in chapter end tests. I like to solve the mathematics problems especially test items 6, 12, 11, 13 and 10 that are experiment, puzzles and cosmic questions* (18 February, 2017).

While the students of high groups who were interested in creativity were high; those of low groups who were interested in creativity were low like as the results of survey. Therefore, these results also support the Barron (2003), Guilford (1950) or Wallach & Kogan's (1965) findings: scoring high on intelligence tests might demonstrate no signs of creativity where as individuals performing poorly in intelligence tests may sometimes create something very original.

And then, most of the students (more than 57%) showed that students who had negative behaviors and characteristics, with no interest in doing

Mathematics weren't enjoyable to participate in taking Mathematical Intelligence Test. And, most of the students (about 75%) showed that positive and desirable behaviors and motivation in creative process but there was no chance to create in real life situations. This study highlights that it is necessary to promote student's divergent thinking which has been lacking in teaching learning situation and create the space for children to learn creatively for creative education to be adopted as an integral part of the schooling experience for a child in Myanmar.

Conclusion

Zelinski (1994) and Maimunah (2004) states that creativity starts with a creative thinking that generates ideas towards solving problems, making improvements, increasing productivity, enhancing effectiveness and adding values. Piaget said that the children at concrete operational stage (10 years age) have been able to understand basic arithmetic, mass, length, transitivity, reversibility and simple mathematical operations (cited in Mok Soon Sang, 2000). In spite of being the middle school students who should have obtained these mathematics skills, the findings clearly point out the weakness of their problem solving abilities. The results of this study seem to be reminding that curriculum of mathematics should be revised and teacher-centered approaches in teaching mathematics should be transformed as soon as possible. In other words, it may be the result of over emphasis on memorization.

The findings of this study provide implications for interventions aiming to improve the logical-mathematical intelligence and creativity in education. It is the duty of parents and teachers to provide support for creative development and help the child to understand the divergent thought and to communicate his ideas freely. They should provide conductive experiences and guidance and they should recognize the individual's creative talent. Teachers should also promote or cultivate creativity in the classroom. Teachers can give project to the students related to community problems like domestic violence. It can help in sprouting creativity because of the human touch and hence emotional connection in it. Classroom environment also plays a crucial role in cultivating creativity and confidence in students. Teachers can make classroom environment where each student's voice

matters a lot. Getting involved with the students in the community is the best way to give push to their creativity.

As indicated through this study, it was restricted to two schools from each district in Yangon Region. In this study, Grade 6 and Grade 7 students were survey. If it is possible, more middle school students from all grade levels should be selected as the sample. This study was limited a cross-sectional design due to scarcity of time and resources. So, a study of longitudinal design is necessary to clarify the students' logical-mathematical intelligence and creative process. Based on the results of this study, many studies should be conducted on other intelligences. If it is possible, it should be expanded on private schools and International schools as those schools have been taught students with the same curriculum but they may apply a variety of approaches, methods, teaching aids and facilities. Since this study was conducted only in Yangon Region, more researches should be done on students' creative process from other regions and states.

In Myanmar, the need to develop creativity in the classroom is in a nascent stage and yet to be emphasized in any major educational policy or planning document. The education in Myanmar is characterized as comprising of dull routines, unmotivated teachers, bored students and rote systems of learning. So, it is very important to be creative learners with high logical-mathematical intelligence. The Myanmar Education System in policy makes no overt recommendations for creativity education to be adopted as an integral part of the schooling experience for a child in Myanmar. Therefore, any such initiative can happen only at an individual level and must stem from an ideology or philosophy that believes in creating the space for children to learn creatively.

Especially, the Myanmar Education System not only encourages the left brain that serves the intellectual but also cultivates the right brain that serves the creativity. Without any motivation, students would lack their creativity to study. Thinking always influenced by creativity and intellectual abilities of a person, when a student is considered to be creative, he has minimum levels of intelligence.

Acknowledgements

We would like to offer respectful gratitude to Acting Rector Dr. Aye Aye Myint, Pro-rector Dr. Pyone Pyone Aung, Yangon University of Education for their official permission to do this research. Especially, I am grateful to Dr. Khin Pyone Yi (Professor and Head of Department, Department of Educational Psychology, Yangon University of Education) for her encouragement and valuable comments. Moreover, we wish to express our deep gratitude to all principals and participants of this study.

References

Brualdi, A, C. (1996) 'Multiple Intelligences: Gardner's Theory. ERIC Digest', Eric Digests. Retrieved October 11, 2016, from *http://www.ericdigests.org/1998-1/multiple.htm. Accessed June 15, 2008*.

Dalal, S. & Rani, M.G. (2013). Relationship of creativity and intelligence of senior secondary students. *International Journal of Humanities and Social Science Invention,* Vol.2 (7), 70-74.

Gardner, H., & Hatch, T. (1989). Multiple intelligences go to school: Educational implications of the theory of multiple intelligences. Educational Researcher,18(8),4-9. Retrieved October 12, 2016, from *http://www.infed.org/mobi/howard-gardner-multiple-intelligences-and education.*

Hoekstra, A.R. (2006). *Logical-Mathematical Intelligence.* International Montessori Schools and Child Development Centers, Brussels, Belgium.

Hopwood, J. (2014). *Social Intelligence and the Creative Process*. Institute of Live Communications, Melbourne, Australia

Isama, A. & Ahmad, J. (2012). *How to Measure Students' Creativity?*. National University of Malaysia, Malaysia. The Asian Conference on the Social Sciences Official Conference Proceedings, Osaka, Japan

Ku YL, Lee PY, Tu CT, Shen MH, Kuo CL (2014). Validating the questionnaire of factors influencing creative process for RN-BSN students in Taiwan. ORIGINAL RESEARCH. *Journal of Nursing Education and Practice*. Retrieved October 12, 2016, from *http://www.sciedu.ca/jnep Volume 5,No.5,2015/pp. 55-64.*

Mina, F. (2008). *DG 9; Promoting Creativity for All Students in Mathematics Education*. The 11th International Congress on Mathematical Education Monterrey, Mexico.

Moe Moe Naing (2008). *A Preliminary Analysis of Multiple Intelligences*. Unpublished doctoral dissertation, Yangon University of Education, Myanmar.

Sternberg, R. J. and Grigorenko, E. L. (2007). *Teaching for Successful Intelligence: To Increase Student Learning and Achievement 2nd Edition*.

Watson, J.S. (2014) Assessing creative process and product in higher education, *Practitioner Research in Higher Education Journal*, 8(1), January, 89-100.

Wily Walnut (2004). Logical-Mathematical Intelligence. Retrieved October 15, 2016 from *http;//www.wilywalnut.com/logical-mathematical-intelligence*.