Learning Styles and Intelligences of the Mathematically Under-Prepared College Entrants in Silliman University

Millard R. Mamhot
Alice A. Mamhot
Department of Mathematics, Silliman University,
Dumaguete City

This study was conducted to primarily find out the preferred learning style and dominant intelligence of mathematically under-prepared students or those taking the Math 1 (Pre-College Algebra) subject. In order to have a frame of reference, a parallel survey was conducted with the regular College Algebra (or Math 11) students using the same instrument. Seven sections of both Pre-College Algebra and College Algebra students were taken as respondents for the study.

Results reveal that among the four general learning styles, both Math 1 and Math 11 students preferred sensual thinking (mastery style). However, they differ significantly on the intuitive thinking (understanding style) as Math 11 students are more inclined to this style than the Math 1 students. For the dominant type of intelligence, Math 1 students were more into Interpersonal Intelligence alone, while for Math 11 students, Musical as well as Interpersonal Intelligences.

It is recommended that teachers apply excitement factor in their activities such that interaction occurs among students, use is made of their senses, and practical application is realized in what they are doing. At the same time, these activities should not only allow physical participation but also entail mental stimulation.

KEYWORDS: learning styles, multiple intelligences, mathematics teaching, mathematically under-prepared students, pre-college algebra, entrance examination, connected knower, problem-posing method, cooperative learning

INTRODUCTION

In a survey of 261 Pre-College Algebra first year students in school year 2009–2010 on the question why students dislike math, 206 or 78.93% said that students dislike math because "Math forces one to give the correct answer." This was followed by "Bad experience in the high school" (55.94%) and "Bad teacher" (50.57%).

In the same survey, the question on what subject was their favorite in high school, 101 or 38.7% said English. Moreover, the survey revealed that Mathematics ranks 7th among favorite high school subjects with only 16.48%. However, on the question on whether Math is a useless subject or not, only 20 or 7% said that it is useless.

These results show that the dislike for mathematics is not from the subject per se but from external factors such as teaching and relating the subject to the outside world when discussed in the classroom. The reason why students rank English as their favorite subject may be attributed to the fact that students are most of the time communicating or interacting with each other in English. In addition, English as a subject could be immediately related to the language frequently used in these students' environment and activities—they watch English movies or TV programs, listen to English songs, and chat or email using English.

The dislike due to lack of relevance of math to the outside world may have been aggravated when the subject is taught without drawing the students' creativity. Having a fixed answer and forcing students to fit their thinking to it could be taken as an affront to the students in their freedom and liberty to think. It could then be noted that "Bad Teacher" and "Bad experience in the high school" are inter–related answers.

According to Keast (2008), when teaching is done with an authoritative figure and imparts information to the students with such information not relevant to the students' reality or life, this approach of teaching is called traditional approach. In the traditional approach, classrooms are conducive for individual activities whereby students are not encouraged to interact. What makes this scenario worse is the fact that the answers to the individual activities are always fixed or known, leaving students with no opportunity to express their creative style or to discover new things. As a result of this traditional approach, students perceive learning mathematics as different from other learning experiences, such as learning science or other subjects. It is therefore clear from the survey that the participants were coming

from classes that were taught using a traditional approach.

The second approach, on the other hand, according to Keast, is the one which focuses on "connected knowers" (Gilligan, 1982; Bleneky et al., 1986 in Keast, 2008). This distinct style of reasoning and learning develops students from their own perspective of being a knower. This style believes that students "trust knowledge that comes from personal experience rather than being handed down from authority" (p. 53). In this approach, teachers prefer to connect with this knower inside each student—to understand him/her, his/her subjectivism and knowledge. Moreover, teachers try to view knowledge not as a cold and impersonal entity given in the classroom; instead, they try to fuse knowledge with the students' emotions and personalities because teachers are aware that students "value learning and knowledge that is woven into their personal relationships, surroundings and environment" (p. 53).

In these two approaches, Freire (1990) labels the former as "banking education", while the latter as "problem-posing method." In "banking education," the students are the depositories and the teacher is the depositor. Instead of communicating, the teacher issues communiqués and makes deposit which the students patiently receive, memorize, and repeat. In the "problem−posing method," on the other hand, the students are increasingly posed with problems relating to themselves in the world and with the world, thus allowing them to feel constantly challenged and obliged to respond to that challenge.

The authors believe that problem-posing method is more appropriate to mathematics teaching because according to Lee-Chua (2001) a math student needs to understand the concepts of the subject and not its superficialities of the problems or solutions or any presentation exhibited. Without understanding of the mathematical concepts, the mathematical expressions and symbols, such as x and y remain to be plain expressions and symbols which are useless to a student. Thus, to understand these expressions, the learner needs to have some grasp of their meaning and relationship to other symbols and expressions, and this can only be pursued once he/she starts asking questions about them. The teacher then, to be effective, should know and understand these questions from the perspective of the students in order to answer them comprehensively. Thus, answers may range from very short ones like "yes" or "no" to theoretical answers that date back to the time of Pythagoras or Fibonacci.

Given these information in the teaching of mathematics, the

researchers realized and identified two things that teachers should consider to effectively develop the students from the perspective of the knower, and these are [1] they must have knowledge on the style for which the students is receptive to, and [2] they must be aware of the faculties or intelligences that the knower possesses to facilitate better communication. This realization paved way to a research study on the learning styles and the kinds of intelligences of Silliman University students.

In June 2006, the Silliman University administration approved the offering of Math 1 or Pre-College Algebra to cater to the needs of mathematically under-prepared college entrants who applied for admission to the university but who fell short of the required percentile rank for admission. In Silliman University, students are admitted when they pass the SUAPE or Silliman University Admission and Placement Examination, wherein the minimum passing SUAPE percentile rank is 40. However, an "on probation status" is given to those who obtain a rank between 20 and 39. From among these college entrants who are placed on probation status, only those who attained a SUAPE Math-component raw score of less than 25 would be required to enroll in Pre-College Algebra or Math 1; those who obtained a SUAPE Math-component raw score of 25 or better would be allowed to enroll in the regular College Algebra course called Math 11, which is a general education subject. However, those college entrants who would be refused admission to Silliman University may opt to stay but are expected to enroll in Math 1. This method of sorting was based on a study by Kilat (2006).

With this scenario, there is a need to look into how Silliman University Math Department can help these mathematically-challenged entrants of the university. The present research, then, aimed to characterize these students enrolled in the Pre−Algebra course in terms of Learning Styles and Intelligences. Specifically, this study was interested to answer the following questions:

1. What are the characteristics of mathematically under-prepared students, or those who are taking Math 1 in terms of learning styles and type of intelligence?
2. Is there a significant difference among the different learning styles between Math 1 and Math 11 students?
3. Is there a significant difference among the different types of intelligences between Math 1 and Math 11 students?

REVIEW OF RELATED LITERATURE

In the United States, according to Gardner (2006), culture and the schools focus most of their attention on linguistic and logical-mathematical intelligence; thus, articulate or logical people of their culture are usually the ones that are highly esteemed. Reality shows that many children who have these gifts do not receive much reinforcement in school. In fact, most children end up being labeled as "learning-disabled," having "ADD or attention deficit disorder," or simply, "underachievers" even though their unique ways of thinking and learning are not addressed appropriately by a heavily-linguistic or logical-mathematical classroom. Equal attention should also be given on individuals who show gifts in the other intelligences: the artists, architects, musicians, naturalists, designers, dancers, therapists, entrepreneurs as they also enrich the world where all people live.

The theory of multiple intelligences proposes a major transformation in the way schools should be run. It suggests that teachers be trained to present their lessons in a wide variety of ways using music, cooperative learning, art activities, role play, multimedia, field trips, inner reflection, and other media.

In line with mathematics classroom settings, findings from previous studies show that there are a number of factors that have effect on students' mathematical abilities. These factors are math anxiety (Arem, 1993; Scarpello, 2007), parental support (Lee–Chua, 2007), knowledge of English language (Esmeralda, 1989), study habits (Nochefranca, 1980), and aptitude for math (Smith, 1991).

In relation to this present study, a previous research was conducted in Silliman University to determine whether the program has achieved its goal of reducing the percentage of failure in College Algebra. The study showed that the percentage of failure before the program was implemented was significantly reduced from 10.98% to 7.20%. Likewise, the decrease on the percentage of those who obtain grades of less than 2.0 (Average) to F (failure) was also significant from 36.77% to 29.67% (Mamhot, Mamhot, & Kilat, 2007). Since the School Year 2006–2007, the Mathematics Department has about five sections of Pre–algebra course. These results indicate that the SUAPE Math–component plays an important role in identifying students who might be mathematically under–prepared to take the regular College Algebra course.

THEORETICAL FRAMEWORK

To find out the preferred learning styles of Math 1 and Math 11 students, the researchers used the four learning styles outlined by Silver, Strong, and Perini (2000). These are Mastery Style, Interpersonal Style, Understanding Style, and Self-expressive Style. These learning styles are based on Jung's (1923 in Silver et al., 2000) two fundamental cognitive functions of the brain, which are perception and judgment. Perception helps the person in absorbing. According to Jung (1923 in Silver, et al., 2000), perception or absorbing knowledge may be through sensing or through intuition, while processing the knowledge may be through thinking or through feeling. From these fundamental functions and sub-functions, there could then be four ways for which people can absorb and process knowledge, and these are: sensing followed by thinking (ST), sensing followed by feeling (SF), intuition followed by thinking (NT), and intuition followed by feeling (NF). These four ways are illustrated in figure 1 below.

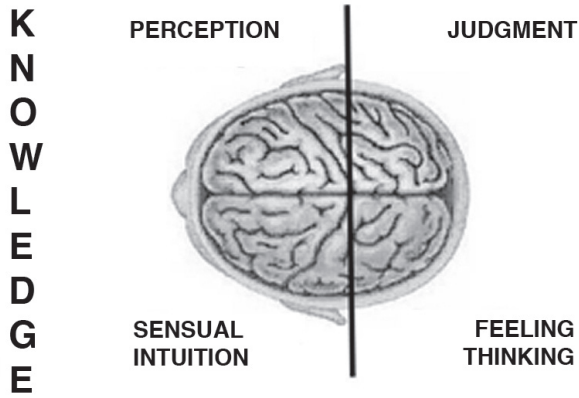

Figure 1. Theory of Learning Based on Carl Jung's Four Dimensions of Personality

Then connecting these to styles, Silver et al. (2000) characterized these as ST to be Mastery Style, SF as Interpersonal Style, NT as Understanding Style, and NF as Self–expressive Style.

Relative to their learning propensity, individuals who prefer to learn through Mastery Style learn best from drill, demonstration, practice, and hands-on experience. Individuals who prefer to learn through interpersonal style learn best through group experiences

and projects, loving attention, personal expression and personal encounters, and role playing. Those who prefer Understanding Style learn best from lectures, reading, logical discussions and debates, and projects of personal interests. Finally, those individuals who prefer to learn through Self-expressive style learn best from creative and artistic activities, open-ended discussions of personal and social values, and activities that enlighten and enhance like myths, human achievement, dramas and other people-oriented activities (Silver et al., 2000).

As for the analysis on the dominant type of intelligence of Math 1 and Math 11 students, a framework on different intelligences was used. It is said that the intelligences or faculties that people may need to understand from the knower could be gleaned based on the theory of multiple intelligences by Dr. Howard Gardner of Harvard University. Gardner (2006) proposes eight different intelligences to account for a broader range of human potential in children and adults. These intelligences are Linguistic intelligence ("word smart"), Logical-mathematical intelligence, ("number/reasoning smart"), Spatial intelligence ("picture smart"), Bodily-Kinesthetic intelligence ("body smart"), Musical intelligence ("music smart"), Interpersonal intelligence ("people smart"), Intrapersonal intelligence ("self smart"), Naturalist intelligence ("nature smart").

The Linguistically intelligent individuals like to read, write, and tell stories, as they are good at memorizing and learn best by saying, hearing, and seeing words. The Logical-mathematically intelligent people like to figure out things, such as doing experiments. They also work with numbers, ask questions, and explore patterns and relationships. Thus, these individuals are good at math, reasoning, logic, and problem-solving; and they learn best by categorizing, classifying, and working with abstracts and relationships. The Spatially intelligent ones like to draw, build, design, create things, daydream, look at pictures, watch movies, and play with machines as they are good in sensing changes, solving puzzles, and reading maps and charts. They learn best by visualizing, dreaming, or activities that use the mind's eye. The Bodily-Kinesthetically intelligent people like to move around, touch, talk, and use body language, making them good at physical activities, such as dance, sports, and play−act. They learn best by touching, moving, interacting with space and processing knowledge through body sensations. The Musically intelligent individuals like to sing, hum tunes, listen to music, play an instrument, and respond to music. However, this interest in music is not just simple interest because they are really good at it −− in picking

up sounds, remembering melodies, noticing pitches or rhythms, and keeping time. With this intelligence, they learn best through rhythm, melody, and music. The Interpersonally intelligent persons like to have lots of friends, to talk to people, and to join groups as they are good at understanding people, leading others, organizing, communicating, manipulating and mediating conflicts. They learn best by sharing, comparing, relating, cooperating and interviewing. In contrast, Intra−personally intelligent individuals like to work alone and pursue their own interests. They are good at understanding self, focusing inward on feelings and dreams, following instincts, pursuing goals and being original, and they learn best by working alone or self−paced instruction, and having own space (E−world Resource Centers, Inc., 2003). Finally, Naturalistic people are more in tune with nature, making them sensitive to changes in the environment they are in, and they are often interested in nurturing and exploring the environment. They learn best by describing features of things.

The location of these different types in the brain is shown in figure 2 below:

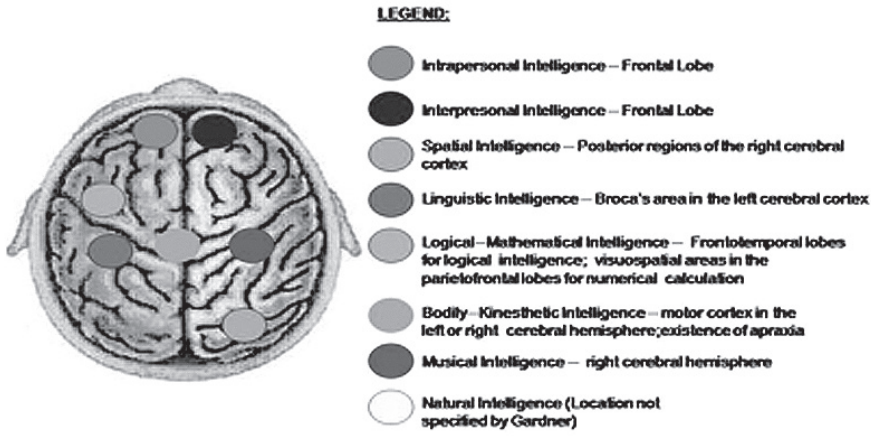

Figure 2. Location of Gardner's Intelligences in the Human Brain

METHODOLOGY

Research Design

The nature of the research study was comparative: distinguishing between the college entrants who were enrolled in Math 1 upon

admission to the university, and those enrolled in Math 11 (College Algebra). However, in comparing these two respondents, more emphasis was done on the characteristics of the under-prepared students.

Respondents

During the school year 2009–2010, a total of seven sections were created for the Pre–Algebra course, and all these seven sections were included for the study. For Math 11, the total number of sections created for the same school year was 17; thus, for uniformity, the researchers randomly chose seven sections to be included in the study. However, in the actual analysis of the data, the total numbers of respondents for each questionnaire were the following: For the learning styles questionnaires, a total of 261 students participated from Math 1 sections, and 265 students from Math 11; while for the intelligences questionnaires, a total of 206 students from Math 1 and 213 students from Math 11.

Instrument

This study used two questionnaires: one for determining the learning styles, and the other one for identifying the types of intelligence. With the help of Dr. Noel Yasi, the Guidance Director of Negros Oriental State University, learning style and intelligences inventories were prepared by the researchers based on Carl Jung's (1923 in Silver, Strong, & Perini, 2000) theory of personality and Howard Gardner's (2006) theory of intelligences, respectively. The questionnaire for learning styles consisted of 20 questions, while for intelligences, 31 questions. Each of the questions in the learning style inventory has four sub–questions for which the respondent ranks from highest (four) to lowest (one). Each of the four sub–questions represents each of the four learning styles. As for the intelligences inventory, the eight intelligences are distributed to the 31 questions with four questions for each of the seven types of intelligences and three questions for the eighth type of intelligence. For each of these questions, the respondent gives a weight according to how the question suits his/her personality. If the respondent feels that the situation described by the question fits him/her best, then he/she responds by answering "Y" for yes; if not, he/she writes "N". If he/she is undecided, he/she writes "0"; and if it is halfway between yes and no, he/she writes "H".

Procedure

These questionnaires were administered to seven sections in Math 1 and to seven sections in Math 11. The administration of the questionnaires was done in two phases: the first phase was for the learning styles conducted on July 2009; the second phase, for intelligences, was conducted on October 2009. In the collation of data, the sub−questions were grouped according to the four learning styles. Averages were used to determine which learning style is preferred for a particular respondent. Same procedure was done in determining the dominant type of intelligence.

RESULTS AND DISCUSSION

Learning Styles Between Math 1 and Math 11 Students

After the data on learning styles were encoded and analyzed, the order of learning preferences of both Math 1 and Math 11 students was identified. This is presented in figure 3 below:

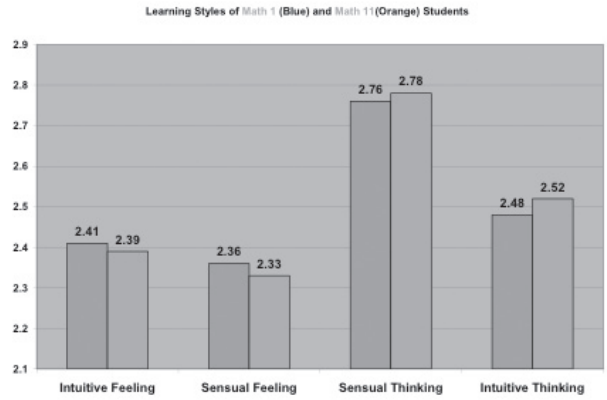

Figure 3. **Learning Styles of Math1 and Math 11 Students**

As can be seen from figure 3, it can be noted that both groups have the same order of preference: Sensual Thinking, Intuitive Thinking, Intuitive Feeling, and Sensual Feeling. What makes this interesting is the finding that majority are sensual thinkers. Sensual thinkers, according to Silver et al. (2000), are students who are most likely realistic and practical. Moreover, they are very active, and they cannot

remain seated while listening to a lecture or a speech; they rather do an activity. With the majority of Math 1 and Math 11 students being sensual thinkers, this may imply that these students tend to prefer physical activities in class, rather than answering exercises or problem sets or listen to explanations of solution of complex mathematical examples on the board. As suggested earlier, the best teaching approach to math is one that involves students in the processing of concepts (Lee-Chua, 2001). In this way, students are encouraged to actively participate, allowing them to do logical thinking while doing physical activities.

Looking deeper into the data, a statistical tool was used to determine whether a significant difference exists between the two groups of respondents' preference. The result is presented in table 1 below:

Table 1.

Difference of Learning Styles between Math 1 and Math 11 Students

Learning Style	Mean Math 11	Mean Math 1	Mean Difference	t-test for Equality of Means (t–value)	p–value (Two–tailed test)	Remarks
1. Intuitive Feeling (NF)	2.39	2.41	-0.02	-1.11	0.267	Not Significant
2. Sensual Feeling (SF)	2.33	2.36	-0.03	-1.32	0.186	Not Significant
3. Sensual Thinking (ST)	2.78	2.76	0.02	0.83	0.405	Not significant
4. Intuitive Thinking (NT)	2.52	2.48	0.047	1.98	0.047	**Significant**

Despite the same order of preference of learning style, it can be noted from table 1 that there is a significant difference in terms of intuitive thinking between Math 1 and Math 11 students. This may imply that Math 11 students are possibly more intuitive thinkers than Math 1 students. According to Silver et al. (2000), intuitive

thinkers could think through things by themselves; or, in a traditional mathematics classroom, they could possibly work by themselves in solving math problems. As described earlier, most mathematics classrooms employ the traditional approach and this means that most activities are conducive for individual survival. Given this significant difference between the two groups of respondents, this could contribute to the affirmation of Math 1 students being under-prepared – they could not endure or tolerate the condition of working or solving problems individually.

Types of Intelligence Between Math 1 and Math 11 students

From the data gathered, the order of the type of intelligences for Math 1 and Math 11 students is presented in figure 4 below:

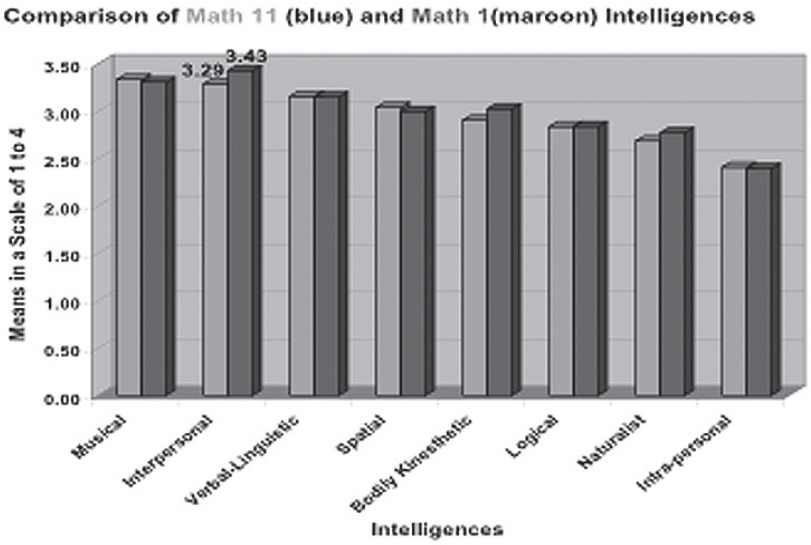

Figure 4. Comparison of Math 11 and Math 1 intelligences

From figure 4 above, the order of types of intelligence among Math 1 students, from highest to lowest, is: Interpersonal, Musical, Verbal–Linguistic, Bodily–Kinesthetic, Spatial, Mathematics–Logical, Naturalist, and Intrapersonal. As for Math 11 students, the order is: Musical, Interpersonal, Verbal–Linguistic, Spatial, Body–Kinesthetic, Mathematics–Logical, Naturalist, and Intrapersonal.

As indicated, the dominant type of intelligence is interpersonal.

According to Gardner (2006), this dominant type of intelligence enables people gifted with this to distinguish the different kinds of moods other people have. Moreover, they know how to read other people's intentions, thus allowing them to respond correctly to those people's actions. This finding could imply that under-prepared students, though they learn logically, know how to interact and to communicate with other people. This supports the suggestion cited earlier for math teachers to give opportunities or activities that allow students to interact with them, teachers, and with other classmates, such as interactive discussions or group works. This is supported by Mark Wahl (1999) as he explained that students with strong interpersonal intelligence have excellent group skills, show empathy for others, and demonstrate leadership. In addition, they are continually drawn into social situations. Another interesting highlight on this figure is the result of Intrapersonal intelligence as the least preferred as this affirms that this group of students are not into learning through individualized tasks or activities. This finding on interpersonal intelligence as the dominant type of intelligence among Math 1 is quite distinct or it could not be possibly questioned as the difference between its mean and the next type's mean is significantly different. This is shown in table 2 below:

Table 2.

Significantly Different Means of Math 1 Students

Math 1	Mean	sd	Significantly Different Means						
1. Interpersonal	3.43	0.59	3.43						
2. Musical	3.30	0.49		3.30					
3. Linguistic	3.15	0.53			3.15				
4. Bodily-Kinesthetic	3.02	0.56				3.02*			
5. Spatial	3.00	0.52				3.00*			
6. Logical	2.84	0.62					2.84*		
7. Naturalist	2.77	0.57					2.77*		
8. Intrapersonal	2.39	0.64						2.39	

*means on the same column do not differ significantly

In comparison to Math 1 students, Interpersonal Intelligence only comes second for Math 11 students, with Musical intelligence as first. This perhaps supports the previous finding that Math 11 students are more intuitive than Math 1 (refer to Table 2), meaning they could work individually which is expected from mathematics classroom settings.

However, the difference of these two types of intelligence's means does not differ significantly, as presented in table 3 below:

Table 3.

Significantly Different Means of Math 11 Students

Math 11	Mean	sd	Significantly Different Means				
Musical	3.33	0.54	3.33*				
Interpersonal	3.29	0.64	3.29*				
Linguistic	3.16	0.53		3.16			
Spatial	3.04	0.46			3.04		
Bodily–Kinesthetic	2.90	0.58				2.90*	
Logical	2.84	0.65				2.84*	
Naturalist	2.68	0.59					2.68
Intrapersonal	2.41	0.64					2.41

*means on the same column do not differ significantly

As seen in Table 3 above, Musical Intelligence and Interpersonal Intelligence do not differ significantly which could be understood that most Math 11 students could have either of the two types of intelligence. This could further imply that for Math 11 students, though they learn through interaction, it is not the only way they could. This is because having the Musical Intelligence, Math 11 students could recognize patterns, rhythms, and symbols which could be translated to the symbols and expressions that are present in mathematics. This recognition and translation could be done individually. Also, as having the Interpersonal Intelligence, they could work with other people in finding solutions in a given mathematical problem or expression.

A deeper understanding on these two groups is a comparison of the means of these two groups of respondents' types of intelligences (Table 4) in the next page:

Table 4.

Difference of Learning Styles between Math 1 and Math 11 Students

Intelligences	Mean		Mean Difference	t-test for Equality of Means (t–value)	p–value (Two–tailed test)	Remarks
	Math 1	Math 11				
Interpersonal	3.43	3.29	0.14	2.35	0.02	Significant
Musical 3.30	3.33	-0.03	-0.57	0.57		Not sig.
Linguistic	3.15	3.16	-0.01	-0.15	0.88	Not sig.
Bodily-Kinesthetic	3.02	2.90	0.12	2.18	0.03	Significant
Spatial 3.00	3.04	-0.04	-0.86	0.39		Not sig.
Logical 2.84	2.84	0	0.03	0.98		Not Sig
Naturalist	2.77	2.68	0.09	1.59	0.11	Not Sig
Intrapersonal	2.39	2.41	-0.02	-0.21	0.84	Not Sig

In using the t–test for the differences of means, it was found that only Interpersonal Intelligence and Body–Kinesthetic Intelligence are significantly different. This may well mean that most Math 1 students, having a greater mean, are more into understanding, relating, and interacting with other people than most Math 11 students. In addition, this could also mean that Math 1 students are more into physical activities as they have a greater mean in the Bodily-Kinesthetic Intelligence. These significant differences would only corroborate with the previous discussion on Math 1 students preferring classroom activities that involve them physically, and exercises that allow them to dynamically participate in the process of solving problems. Through this experience, students would be able to understand concepts better which is what every mathematics classroom's primary goal is as suggested by Lee-Chua (2001).

SUMMARY, CONCLUSION, AND RECOMMENDATIONS

This study aimed to determine the preferred learning style and the dominant type of intelligence of mathematically under-prepared students of Silliman University. In achieving these goals and verifying factors that affected these results, a comparative study was done between these under-prepared students who are taking the preparatory course Math 1 and those who are considered to be

prepared students who are taking Math 11. Moreover, these students prefer the sensing-thinking or mastery style as their learning style, and they dominantly have Interpersonal Intelligence. As for the results of Math 11 students, their dominant learning style is sensing-thinking; however, this group of students has two dominant types of intelligence: Musical and Interpersonal.

With these descriptions of the two groups of respondents, the researchers concluded that Math 1 students are receptive using their senses and process knowledge by thinking. Adding their having Interpersonal Intelligence, it could be said that Math 1 students prefer to interact with other people and to use their senses in acquiring knowledge. In comparison, Math 11 students, though they are also sensual thinkers, have a significantly higher intuitive-thinking style. This means that they could also receive knowledge using the mind or through imagination and process by thinking. This is further supported by their two dominant types of intelligence because, first, being musically-inclined, they can recognize patterns or use their imagination in understanding patterns; and second, having interpersonal intelligence, they could also work with others using their senses and, as indicated earlier, process by thinking.

With these results, the researchers would recommend two things. First, since Math 1 students are not likely receptive to teaching that process knowledge through thinking but are more receptive through sensual thinking (mastery style) and based on the suggestion of Silver et al. (2000), it is recommended that in teaching students who prefer sensing–thinking (mastery style), the teacher should employ drills, hands-on experience, and practices that have immediate and practical use. In connection with their dominant type of intelligence, the Interpersonal, Wahl (1999) suggests that math teachers of students with strong Interpersonal intelligence should incorporate in their teaching the anecdotes and the history behind the material their students are using. Moreover, the effective methods for these students are cooperative learning and cross–cultural lessons. In short, teachers should introduce activities that involve interaction among students that make use of their senses and that allow them to realize practical application in what they are doing.

Because the findings on Math 1 students' preferred learning style and dominant type of intelligence encourage the ideas of Wahl (1999) on cooperative learning and Silver (2000) on interactive classroom setting, the researchers propose that math teachers could possibly employ one teaching strategy: applying the excitement factor.

According to James Bjork (2004 in Wallis 2004) of the US National Institute on Alcohol and Alcoholism in Maryland, teens have immature nucleus accumbens in their adolescent stage, so that at this stage they have motivational deficit which means that either they can have an excitement factor or a low effort factor for doing things. Since it seems difficult to uphold a low effort factor in a math class, a math teacher has no choice but to apply high excitement factor. This factor involves actions not only from the teacher but also from the students. Further, with this excitement factor, teachers offer students activities inside the classroom that do not only allow physical participation—team work, communication, and interaction—but also entail mental stimulation—thinking, planning, and organizing.

The theory of multiple intelligences and learning styles attracts educators because it offers different pathways for students to learn as well as for teachers to teach (Hoerr, 2002). And certainly it is not exclusive to mathematics. In the book of Silver et al., examples abound on how to teach a given subject matter using a specific learning style. Hence, techniques in teaching with the knowledge on students' intelligence and learning style undoubtedly bring success to the teaching and learning processes.

The effectiveness of the multiple intelligence theory is supported by the findings of a study conducted in Harvard University known as "Project Zero." The study showed that 78% of 41 schools realized gains on standardized achievement; 63% of these attributed the growth to practices inspired by multiple intelligences theory. Seventy-eight percent of the schools reported improved performances of students having learning difficulties; 80% reported improvement in parent participation; and 81% reported on improved student discipline.

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