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Students' Dominant Intelligence and Performance in Chemistry

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Abstract

AIM: The study aimed to describe the influence of multiple intelligences to the chemistry performance of the Grade 7 students. The research participants were composed of 59 intact population of grade 7 in Manlabong National High School. They were grouped based on their dominant intelligence.

METHODOLOGY: The study was conducted for one quarter and employed the descriptive research method. Questionnaires were used as the data gathering tool.

RESULTS: Based on the sub-problems the following were the findings: (1) the participants were mostly naturalistic intelligent individuals; (2) using one-way ANOVA, it was determined that there were no significant differences in the performance of the groups in chemistry performances except in achievement test and linguistic intelligence inclined seatwork activities. However, Scheffe post hoc test disproved this by giving no significant differences in the performances in any pairwise comparisons; and (3) the most appreciated chemistry activities were those inclined to visual-spatial intelligence.

CONCLUSION: It was concluded that the research participants have dominant naturalistic intelligence, but visual-spatial related chemistry activities were the common preferred activities they like to do. Multiple Intelligence inclined activities had a diminished performance gap among the diverse students in class.

Keywords: Dominant intelligence, Chemistry Performances, MI-inclined Chemistry Activities

INTRODUCTION

The theory of multiple intelligences (MI) states that human beings differ from one another, and there is absolutely no reason to teach and assess all individuals in the identical way (Gardner, 2011). The theory of MI proposes a major transformation in education. It suggests that teachers must teach to a broader range of talents and skills in order to accommodate these different intelligences (Brualdi, 1996).

Gardner's ideas sit well with science which has long been associated with logical people. There were notions that say science, especially chemistry, is a logical-math-biased subject. Indeed, logical math intelligence, together with linguistic and visual–spatial, was found to be a key to achievement in chemistry (Wright, 2004). This gave the idea that chemistry subject entertains not only logical-math intelligence but also other intelligences by providing different avenues of activities that match with the students' dominant intelligence. Kwen (2002) suggested a list of learning activities in chemistry to enhance the learning of the students with strengths in various intelligences.

In Manlabong National High School, the grade 7 students had shown multiple intelligences like dancing, singing, academics (e.g. science and math), spatial and other activities which require other forms

of intelligences. When assessed using the Multiple Intelligence Test, the class had diverse intelligences which called for varied activities, strategies in teaching and assessments.

The aforementioned had become the basis of this study. It investigated the influence of dominant intelligence of the research participants on various chemistry undertakings which were termed as *chemistry performance.*

Objectives

The study determined the dominant intelligence profile of the research participants, significant differences in the chemistry performance (MI-inclined seatwork, laboratory examination performance, achievement test and academic grade) and the most appreciated chemistry activity. Describing the influence of multiple intelligences on various chemistry performances give educators a hint on effective strategies/activities in teaching chemistry with respect to multiple intelligences.

Literature Review

The Multiple Intelligence Theory

Gardner 1983 in Brualdi (1996), argued that culture plays a large role in the development of the intelligences. The cultural value placed upon the ability to perform certain tasks provides the motivation to become skilled in those areas. Thus, while particular intelligences might be highly evolved in many people of one culture, those same intelligences might not be as developed in the individuals of another (Brualdi, 1996).

Salandanan (2002) says that most teaching strategies employed in the past cater to the linguistics only since most of the activities revolve in the word-dominated learning. Another dominant strategy focuses on learning about numbers alone. This strategy forgets sensitivity to other possibly less discovered ability that may go along. For instance, a single strategy alone on math-inclined individuals may ignore their visual-spatial intelligence.

Abaquin (in Chen, 2009) says that at MI schools, the goal of using multiple intelligences in the classroom is to gain understanding. Instead of teaching lessons in eight ways to tap the eight intelligences, the teachers and students are empowered to choose strategies that they prefer most to learn.

According to Wilson (2014), the dominant intelligences were: **Verbal/Linguistic** – deals with abilities in the complex acquisition, formation, and processing of language; **Logical/mathematical -** deals with the ability to think logically; inductively, and to some degree deductively; categorically; to recognize patterns, as well as the ability to see and work with abstract concepts; **Musical** – deals with the ability to create or interpret music; **Spatial Intelligence** –deals with the ability to perceive images; **Bodily/Kinesthetic intelligence -** deals with the gift of physical movement that of both the fine and/or the large muscle systems; **Interpersonal** – deals with the ability to understand and communicate with others and to facilitate relationships and group processes; **Intrapersonal** – deals with the ability to be somewhat insulated from one's peers; to have a strong sense of self, and **Naturalistic intelligence** are often keenly aware of their surroundings and changes in their environments.

Performance in Chemistry

Beluso (1993) has findings of students with a generally poor performance in chemistry due to low level of comprehension which resulted to their inability to analyze and solve problems correctly. She claims, however, that sex, home location, parents' educational attainment, exposure to print media,

exposure to electronic media and teacher factor did not influence the performance of the participants in chemistry. Further, Espinosa, et.al (2013) expresses his experience and observations that in chemistry, the students appeared to start classes with many expectations, questions and great interest are not sustained because they find the subject too abstract and mathematical; therefore it requires a special way of thinking to be able to learn it.

Kwen, (2002) suggested list of activities that could be used in teaching chemistry to increase the performance by recognizing multiple intelligences. The activities were varied and appropriate for each intelligence type.

Multiple Intelligence and Performance in Chemistry-

Xie and Lin (2009) conducted research which aimed at fusing the multiple intelligences theories with the teaching of one chosen course: color theory. Students from the experimental group performed significantly better than students in the control group in actual hands–on design project assignments.

Ghazi (2011) investigated the relationship between students' self-perceived multiple intelligences and their academic achievement. A significant correlation was found between self-perceived linguistic, logical, interpersonal, intrapersonal, naturalistic intelligence and academic achievement. There was insignificant correlation between self-perceived musical intelligence and academic achievement. The study also showed the weak relationship between self-perceived kinesthetic intelligence and academic achievement.

Martinez (2002) sought the relationship between the students' dominant intelligence score and chemistry achievement scores classified into three cognitive levels: knowledge, comprehension, and application. The findings of the study revealed that students have different dominant intelligence. The study also showed that interpersonal, naturalistic, intrapersonal, verbal, and logical students performed better compared to other MI groups in chemistry achievement test. Positive correlations were found between dominant intelligence scores and mean scores in knowledge level of interpersonal, intrapersonal, verbal, logical, and visual students. Positive correlations were also found between dominant intelligence scores and mean scores in comprehension level of interpersonal, intrapersonal, verbal, and logical students. Application mean scores had positive correlations with dominant intelligence scores of interpersonal, naturalistic, and logical students.

Napiere (2012) examined the dominant intelligences and learning preference of 232 freshmen in a school in Cagayan de Oro City. The dominant modes of delivery and assessment tools used by 14 instructors were also examined. Results revealed that the students had dominant musical-rhythmic and spatial-visual intelligences. They prefer to learn through linguistic and intrapersonal means. The dominant modes of delivery used were intrapersonal and logic based modes. The assessment tools used were primarily related to the interpersonal and logic-mathematical intelligences. Correlation results showed that students who had strong interpersonal intelligence prefer to learn in linguistic ways. Each mode of delivery used is significantly related to each assessment tool.

Arellano (2010) found out that there was a significant difference in the level of multiple intelligences and learning preferences of students in selected schools of Makilala Central District except in Saguing Elementary School.

And, Curabo (2005) made a research to determine the effectiveness and suitability of the multimedia software in chemistry on students with varied dominant intelligences. The result showed that the use of multimedia software improved the performance of all the intelligence groups in the achievement test. The

result of the one–way ANOVA showed significant difference in the gain score of linguistic intelligence, which differed significantly better than other intelligent groups. The linguistic group obtained the highest mean score in the exercises given after the presentation of each topic.

METHODS

Research Design

This study was conducted using the descriptive research method. According to (Anastas, 1999), descriptive research is used to obtain information concerning the current status of the phenomena and to describe "what exists" with respect to variables or conditions in a situation. Gay in Albano (2006) defines descriptive research as involving collection of data in order to test the hypothesis or to answer concerning the current status of the subject of the study. This study is descriptive in a sense that it describes the profile of the students along with chemistry performances.

Research Participants

The research participants were composed of the intact population of Grade 7 students in Manlabong National High School who were taking chemistry subject during the first quarter of the school year 2014-2015.

The average age profile of the participants was 12 years old. The participants were all residing and schooling in the countryside, a nature-rich environment. The mode of transportation is in the form of single motorcycle but most students just walk from a range of 20 steps to 3 kilometers in going to school. The livelihood of the locals was mostly fishing and copra-processing.

Research Instruments

This study used multiple intelligence assessment tool, students' perception on chemistry activities, laboratory exam and achievement test as instruments to determine the multiple intelligence and performance. Multiple intelligence assessment was made online by literacy.org which they claimed was from Dr. Armstrong. The rest of the instruments were teacher-made. All the instruments had established validity confirmed by the experts on the field. Reliability was also estimated using split-half for students' perception and test-retest for the rest of the instruments.

Data Collection Procedures

The study used questionnaires for data gathering. The assessment tool for MI and the students' perception had a rating data. The laboratory exam, achievement test and seatwork had scored data.

Data Analysis Procedures

ANOVA was used to find out the significant difference in chemistry performance of the groups. The data were ratio. Santos (2006) said that ANOVA is used to test the hypothesized non-significance difference among several groups. Further, Scheffe hoc post- test was used. Lewis (2004) said that it is a test to determine significant difference in the means of group in a direct pairwise comparison.

RESULTS and DISCUSSION

Dominant intelligence profile of the grade 7 chemistry students.

The identified dominant intelligence among the research participants with corresponding number of students in that group of intelligence were: verbal 2, mathematical-logical 8, visual-spatial 5, bodily-kinesthetic 8, musical-rhythmical 5, interpersonal 4, intrapersonal 8, and naturalist 19. Most students are naturalistic. This may be accounted by the nature-rich environment location of the participants. Solapur (2014) found out naturalistic students from the rural areas were bigger in percentage compared to urban areas. Gardner (1983) in Brualdi (1996) says that the development of this forms of intelligence depends on both biological and cultural aspects.

Chemistry Performances

a. Seatwork inclined to verbal intelligence- the researcher gave writing of poem on solutions and essay on neutralization. ANOVA gives significant difference (0.03) in the performance of the dominant intelligence groups in this kind of seatwork activity. However, this was disproved when Scheffe post hoc tests was conducted to affirm this result by a pairwise comparison. Situations like this arises when running a more complex ANOVA - repeated measures, especially when there is unequal sizes of sample. Even though there was no significantly difference in performance, it shows noticeable data that the following pair of groups had somewhat great *dissimilarities* in mean performance in verbal-inclined seatwork activities. These pair of groups were: linguistic vs. logical; linguistic vs. visual-spatial; logical vs. musical, logical vs. social; and visual-spatial vs. musical.

There was also obvious difference between: logical vs. musical and visual-spatial vs. musical, in favor of the latter group. Musical intelligence might be more close to linguistic intelligence when it comes to verbal or word activities than logical intelligence do. Though, the result of the study is quite contradicting to other researches because dominance on logical mathematical necessitates one to be good in language comprehension. Abedi & Lord (1995) found out that language proficiency is a factor in mathematics performance. On the other hand, West (1991) in Sword (2011) says that verbal and logical were both associated with the left hemisphere part of the brain. They both process information and questions in a step-by-step process. However, the only reason that a researcher can give is that, the verbal-linguistic seatwork activities given to the participants were about composing of poems and writing essays which are verbal dominating activities. Most inclined in math may be associated with language comprehension but most math- inclined people have difficulty in constructing words. They may have high reasoning ability but this is about on reasoning abstractly and quantitatively. “Mathematical inclined participants are low in practical fluency”.

Similarly, the obvious dissimilarities in the performance of visual- spatial and musical in favor of the latter group may also lie on the fact that visual spatial is more on picturing the scene but musical inclined people may work like linguistic especially in composing poems. Musical inclined people have high inclination also on rhythmical properties which the poems also possess.

b. Seatwork inclined to logical-spatial intelligence- In this study, the researcher gave a problem on computation about the concentration of solution. ANOVA indicates no significant difference among the group in the math-logical inclined seatwork activity. This activity brought no gap of performance among the groups. They perform at par with one another in this task. However, based on the actual mean data, the logical group had the highest mean on this kind of seatwork. Unfortunately, most groups had low mean performance for the math–inclined seatwork. The researcher found out that this kind of seatwork activity would have a score not favorable to the rest of the intelligence groups.

c. Seatwork inclined to visual-spatial intelligence- The visual-related seatwork was all about analysis of graph, following mnemonics, and combining compounds. No significant difference in performance was obtained from this kind of seatwork activities. These activities gave the entire groups a better and at par performance.

d. Seatwork inclined to naturalistic intelligence- These were all about classification of matter as: elements and compounds, metal, nonmetal, and metalloids and acid or base. All groups have high mean performance in this type of seatwork activity. It is concluded that giving naturalistic inclined seatwork activities enhance the performance of the students. It bridges the gap between the groups as well. Further, there was no significant difference in performance among the groups in this kind of seatwork activity.

Table 1. ANOVA on Various MI-inclined Chemistry Activities

	Source of Variation	SS	Df	Mean Square	F	Sig.
a)Verbal-inclined seatwork	b/n groups	129.19	7	18.46	2.39*	0.03
	w/n groups	393.93	51	7.72		
	Total	523.19	58			
b)Logical-inclined seatwork	b/n groups	74.95	7	10.71	0.62	0.74
	w/n groups	884.58	51	17.35		
	Total	959.53	58			
c)Visual-inclined seatwork	b/n groups	32.27	7	4.61	0.45	0.87
	w/n groups	523.58	51	10.27		
	Total	555.86	58			
d)Naturalistic-inclined seatwork	b/n groups	48.63	7	6.95	0.58	0.77
	w/n groups	609.81	51	11.96		
	Total	658.44	58			

*significant @ 0.05.

Laboratory Exam Performance- This refers to the accomplishments of the participants in the laboratory exam. The items of which were obtained from all the actual laboratory activities conducted throughout the first quarter. The list of activities indicated in table 2 were bases of the performances of the groups in actual group experiments and laboratory exam.

Table 2. List of laboratory Activities

Date	Laboratory Activities
06-05-2014	What type of sugar will dissolve faster tap water?
06-06-2014	Which will dissolve in hot and in cold water: Sugar or
06-11-2014	Preparing saturated and unsaturated solution
06-18-2014	Comparing the properties of pure substance and
07-10-2014	Making eggplant indicator
07-25-2014	[a]Cite proper ways of handling strong acids and bases

The summary table of one-way ANOVA in table **3** showed no significant difference in the mean performance of the groups in laboratory exam. It seem**ed that** the number of times the participants use**d** their dominant intelligence in an experiment and presentation of output ha**d** no direct relation with their mean performance in laboratory exam. In fact, musical intelligence was used **(tapped)** rarely in the presentation of the output for the activity. But it turns out that musical intelligence has the highest mean performance in the laboratory exam. The results of the laboratory activities may be related to the study of Landsberg (2010) who found that giving supplemental kinesthetic exercises to students did not increase their exam result in chemistry. It can be summed that the utilization of one's strength or skill on a particular intelligence during actual activity would not influence his/her laboratory exam result in chemistry.

Table 3 ANOVA among MI Groups on Laboratory Activities

Source of	Sum of	df	Mean	F	Sig.
Between	241.68	7	34.53	1.27	0.28
Within Groups	1385.00	51	27.16		
Total	1626.68	58			

Achievement test- The performance obtained from this instrument refers to the equivalent grade of the students from the result of their achievement test. One-way ANOVA in table 4, showed that there was a significant difference in the achievement result of the dominant intelligence group. However, Scheffe post hoc test cannot find significant difference in mean performance from any direct pairwise comparison. The situation may arose from too high errors that the unequal size of samples bring.

However, the naturalistic and visual-spatial groups who were the most active in laboratory activities and high in seatwork activities were also found to have higher mean in achievement test. In this study, doing activities inclined to any particular intelligence more often, such as in laboratory activities and seatwork activities would mean a possibility of increased achievement test performance.

Table 4. ANOVA on Achievement Test Performance

Source of	Sum of	df	Mean	F	Sig.
Between	204.54	7	29.22	2.39*	0.03
Within Groups	622.86	51	12.21		
Total	827.39	58			

***significant @ 0.05**

Academic grade- This refers to the final grade of the students for the first quarter which was obtained from four components of the grading system. The grade in chemistry was computed by considering all the seatwork and lab activities and other related areas.

Table 5 shows that there was no significant difference in the academic grade among the groups. When different roles were allowed in activities by students with varied dominant intelligence within the group, the gap between these intelligences in terms of performance was reduced. When students had shown interest in what they are doing, this affects their performance and grade positively. The dominance of a single or few groups were diminished.

Table 5. ANOVA of academic grade performance

Source of Variation	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	188.13	7	26.88	1.66	0.14
Within Groups	825.40	51	16.18		
Total	1013.56	58			

MOST APPRECIATED CHEMISTRY ACTIVITIES- The most appreciated chemistry activities was measured using the instrument "Students' Perception towards Chemistry Activities". It was a rating scale that determines the degree of their likeness towards the list of chemistry activities. The result said that the most appreciated activities were those inclined to visual intelligence. This result is in consonance with the findings of Silverman (2014) who found out that one-third of his 750 student-participants were strongly visual-spatial, and another 30% were moderately visual-spatial.

Implication to Teaching

One way to be fair to students with varied multiple intelligence is to give them activities where all of them perform, far from the dominance of a single or few groups. In this way, the failure of most students in chemistry subject would be reduced. West in Silverman (2014) quoted that the 21st century employees will require strong visual skills. In sum, educators should focus more on the preference of the learners in learning and on what the future requires from them. Working with visuals and games they like, probably are the most suited strategies nowadays.

Conclusions

Based on the obtained data and results of the study, the following conclusions were drawn:

1. Naturalist is the participants' dominant intelligence.
2. Doing the preferred role in group activities gives one a competitive grade performance and at par laboratory exam result, thus there was no significant differences in the chemistry performances among the groups.
3. Visual-spatial inclined chemistry activity is the most appreciated type of activities of the research participants.

Recommendations

Based on the summary of findings and conclusions, the researcher recommends the following:

1. The MI profile be conducted in the class using the standard assessment and use it for triangulation purposes in a study involving dominant intelligence and chemistry performance.
2. Conduct a study whether most tapped DI is a factor in chemistry performance.
3. Giving more MI-inclined activities suitable to the identified MI profile of the class is encouraged to make the students participate more actively in the class.

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