Effects of HOTS Techniques through Modular Instructions in Teaching High School Chemistry in MSU-Balindong High School

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Abstract—**A combined quantitative-qualitative techniques and analysis was used in this experimental study involving eighty seven (87) third year high school students in MSU-Balindong Community High School during 2007-2008 calendar years. They were then distributed into three (3) groups: experimental group, control group and the pilot testing group. The respondent's performance on HOTS questions, learning style, motivation style, creativity and interest were measured at the beginning and at the end of the study. Experimental group exposure on modular instructions using HOTS techniques involving multimodal strategies shows significant effect as compared to the control group. Most of them favored the HOTS techniques and modular instructions and they found it difficult yet more interesting, challenging and enjoyable.**

Index Terms—**Critical thinking, creativity, and motivation, modular instruction, science education.**

I. INTRODUCTION

Quantitative – qualitative techniques have been used to explore the effects of Higher Order Thinking Skills (HOTS) through modular instructions in teaching high school chemistry. As teacher, teaching is a profession of paramount importance both qualitatively and quantitatively important in serving education. So, we educator is obligated to not simply to bring out but to bring out the best among our students. A major issue faced by the educational system worldwide like in the Philippines case in particular is the low performance of the students in Science and Mathematics. Filipino students ranked 3rd and 4th from the bottom in math and science respectively on the two consecutive study conducted by the Third International Math and Science Survey TIMSS and TIMSS-R [1].

This low and alarming performance evidently indicate that Filipino students are not sufficiently trained to answer HOTS questions. Valdez [2]" research findings revealed that students in MSU-Balindong Community School were poor in HOTS questions in general science because apparently they are used to deal with simple recall questions only.

Result of the System Wide Admission and Scholarship Examination (SASE) given by the Mindanao State University (MSU) showed that some of the high schools department in the university could not make even 1% of their students pass the said examination. The trend of MSU-Balindong performance is a case in point. In the year 2005-2006, only seven (7) out of 70 graduating students who took the SASE examination were able to pass the said examination. In 2006-2007, only seven (7) out of 60 students who took the same successfully hurdled the test. The results of other examinations taken by graduating students of MSU- Balindong Community High School – i.e. DOST-SEI Scholarship Test – do not provide any consolation. None of the examinees passed the scholarship examination.

To eradicate or just improve the quality education HOTS development among students is a pivotal technique for teaching instructions. HOTS are a creative program designed to enhance students learning style, creativity, interest, motivation and achievement. Research findings internationally, showed that HOTS produce learning gains of low-achieving students in grades 4-7 who demonstrate a great intellectual potential that they want to be successful in school. The right educational approach in the hands of a good teacher, and with the support of a principal can unleash this ability [3]. The evaluation made of the MSU-Balindong student's performance serves the purpose of a needs analysis. The result points up the need for some intervention strategy that will lift the abilities of students to levels competitive enough to put them on a par with products of other schools, and enable them to pass qualifying and scholarship examinations. Thus, this study is timely and relevance to explore ways to improve student's skills not only for short term goals but, more importantly, for life long and self –directed publication.

II. RESEARCH METHODOLOGY

A. Participant of the Study

A total of 87 third year high school students in MSU-Balindong school year 2007-2008 participated in the study. They were grouped into three based on the matched – pairing of their previous grades in chemistry. The matched pair is then randomly assigned to respective groups by drawing lots. A total of 38 students are assigned each group in the experimental and control, while 11 students were assigned in the pilot testing of instruments to established validity and reliability.

B. Research Design and Methods

This study was a quasi – experimental using quantitative and qualitative research design. Quantitative and qualitative

data was collected during the whole duration of the second grading period using modules for experimental group and chalk-board approach in the control group. Modules consisting three lessons: chemical language, chemical quantities, and stoichiometry designed by the researcher. Each module consist a variety of teaching methods and activities, both qualitative and quantitative approach which calls for HOTS among learners. Both groups were pre-tested and post-tested using HOTS questions lifted from the TIMSS – like test items in the chemistry components. Moreover, students learning style, motivation style, creativity and interest were also measured before and after the conduct of the study using adapted standardized instruments from expert. Impressions of students in the experimental group were measured qualitatively through journal writing, and reflections. Self assessment questionnaire was also used to obtained additional information about the modular instructions involving HOTS in the teaching-learning process.

III. RESULTS

Descriptive statistics and t-test was used to investigate the effects of HOTS techniques through modular instructions in teaching high school chemistry.

A. Pre-Test and Pos-Test Performance

As shown in Fig. 1 and Table I pre-test performance in both groups were almost equal. However, in the post-test experimental group performance improved significantly obtaining a mean gain of 18.6 having *t*-value of 0.009 which is significant at $\alpha = .05$
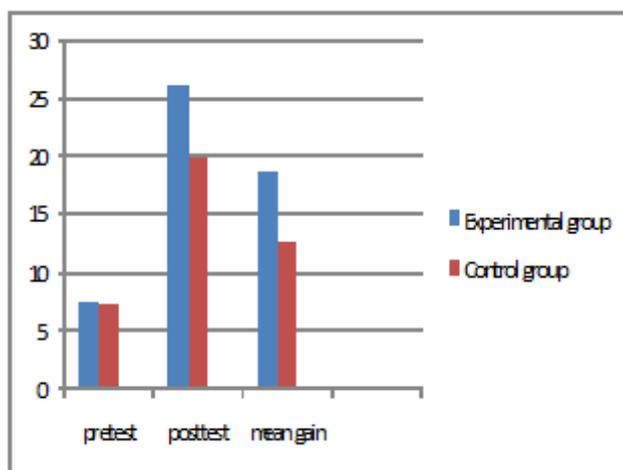

Fig. 1. Pre-test and post-test mean scores of the respondents.

TABLE I: RESPONDENTS PRE-TEST AND POST-TEST

Group	Mean	Mean Difference	SD	t	decision
Exp	26.14				H_o
Contrl	19.97	6.17	13.52	.009	rejected

B. Performance Level of Respondents

As shown in Table II, performance level of experimental and control group in the HOTS questions during pre-test fells in the poor level (100%). However, in the post-test experimental group performance level distributed into poor, below average, average and above average while majority in the control group remained in the poor performance level.

TABLE II: PERFORMANCE LEVEL OF RESPONDNETS

Score range	Qual. label	Experimental group			Control group		
		Pre-test %	Post-test F	%	Pre-test %	Post-test F	%
56-60	Superior						
50-55	High ave						
40-49	Above ave.		2	5.4			
30-39	Average		14	37.8		6	16.2
29-25	Below ave		1	2.7		5	13.5
24-below	Poor	100	20	54	100	26	70.3

Number of cases: 37

C. Learning Style

Students learning style was assessed using "what's' you're learning style which includes visual, auditory, and kinaesthetic [4]. Table 3 present the respondents learning style before and after the study conducted. As shown in Table III, students learning style varies before and after treatment and or teaching. Many respondents in experimental group claimed auditory learning style before treatment, however, after treatment, many of them favored kinaesthetic, followed by visual, and auditory. Learning style in the control group remained the same after teaching the lesson. The shifting of the experimental group learning style was probably influenced by the different activities in the modules. Research conducted internationally showed a negligible correlation between performance and learning style [5]. Buttler [6] believed that learning styles are neutral. All learning style can be successful, but they also could become a stumbling block when overused or applied inappropriately.

TABLE III: LEARNING STYLE OF RESPONDENTS

LS	Experimental group				Control group			
	Before F	%	After F	%	Before F	%	After F	%
V	10	27	11	33.3	8	21	9	27.3
A	15	40.5	7	21.2	11	29.7	9	27.3
K	10	27	13	39.4	16	42.1	15	45.4
V & K	2	5.4	0		1	2.6		
V & A			2	6.1	1	2.6		
Total	37		33		37		33	

Legend: LS – learning style   V - visual
         A – Auditory   K – kinaesthetic

D. Motivation Style

Student's motivation style was measured using the *Comer motivation style questionnaire* which includes goal, social, and learning oriented [7]. Table IV shows that experimental group motivation style remained the same before and after treatment. However, response on socially oriented motivation style increases, the same as true with the learning oriented. In the case of control group, they were socially and learning oriented before teaching while after teaching 50% becomes socially oriented. Sustaining motivation to learn is strongly dependent on the learner confidence in his or her potential for learning and motivation style [8]. Caster [9] research reports show no

significant relationship between motivation and motivation style.

TABLE IV: RESPONDENTS MOTIVATION STYLE

MS	Experimental group				Control group			
	Before		After		Before		After	
	F	%	F	%	F	%	F	%
G	11	35.4	12	34.3	5	15.6	9	25
S	4	12.9	9	25.7	11	34.3	18	50
L	8	25.8	11	31.4	11	34.3	9	25
G&L	1	3.2	2	5.7	2	6.3		
G&S	7	22.6	1	2.9	1	3.1		
S&L					2	6.3		
Total	31		35		32		36	

Legend: MS-motivation style   G-goal oriented
      S-socially oriented   L-learning oriented

E. Creativity and Interest

Student's creativity and interest was measured using the *Schafer creativity attitude survey* [10]. As shown in Table V, control group creativity and interest before teaching was above average, average, and low average. However, after teaching the lessons their creativity and interest become poor, no more above average and only few remained average. These dramatic changes may be affected to the difficulty level of topics. Their creativity and interest were not reawakening due to fact that they were not exposed to any activities. In the case of experimental group, many of them have average creativity and interest and few above average. After treatment, the percentage of low average and above average increases. However, the above average creativity decreases but with the corresponding response of 8.6% superior in their creativity and interest. Creativity and interest is a vitally important aspect of daily life. It will benefit both extrinsic and intrinsic. Creativity is a dimension of the person and may not be dependent on the intelligent aspect of a person [11].

TABLE V: CREATIVITY AND INTEREST OF RESPONDENTS

Range score	Qual. label	Experimental group					Control group			
		Before		After			Before		After	
		F	%	F	%		F	%	F	%
1-3	Poor								10	30.5
4-6	Low ave.	2	6.3	5	14.3		8	21.6	11	33
7-9	Average	21	65.6	25	71.4		25	67.6	12	36.4
10-12	Above ave.	9	28	2	5.7		4	10.8		
13-15	Superior			3	8.6					
	Total	32		35			37		33	

F. Self Assessment

Self assessment evaluates the quality and contributions of HOTS through modular instructions to the students learning and knowledge gained after the treatment. (See Table VI)

TABLE VI: SUMMARY OF SELF-ASSESSMENT ON THE USE OF MODULAR INSTRUCTIONS USING HOTS TECHNIQUES

Assessment Questions	Response	F	%
How would you rate the modules?	Above average	12	32.4
Do the activities in the modules arouse your interest?	Yes	30	81.0
Do the modules improve your creativity and interest in chemistry?	Yes	33	89.2
What is/are the most interesting activity?	Balancing equation	15	40.5
What activity enhances your creativeness the most?	Concept mapping	9	24.3
What activity enhances your thinking the most?	Limiting reagent analysis	10	27.0
Do the content and activities enhance your learning style?	Yes	20	54.0
Do HOTS techniques used encourage and motivate you to study and learn chemistry?	Yes	17	32.4
What are your comments & suggestions?	None	22	59.5
Some comments	Hard, perfect, repeat	15	40.5

IV. DISCUSSION AND IMPLICATIONS

On the basis of pre-test and post-test profiles using HOTS questions, the respondents in both groups performed better during post-test, compared to their pre-test performance. This may be due to the discussion of concepts that are related equally to the concepts covered by the HOTS questions. However, experimental group performed better in the post-test than their counterparts. This implies that the modular instructions using HOTS techniques improve their achievement in chemistry. On the other hand, the poor performance of the respondents on HOTS questions demands serious attention. One may have to take a look at the prerequisite stock knowledge and skills learned by the students. A more critical examination must be done in order to determine if there is a need to re-teach the concept. An important implication is that the respondents are not used or properly trained to answering HOTS questions. Worth noting is the fact that although there is some discernible improvement in the performance of the experimental group participants compared to the control group, however, some participants in the experimental group performance is still poor after treatment,. The small changes in respondents' performance after treatment may be attributed to some factors beyond the control by the researcher. These include limited time and contact due to the Ramadhan season, tardiness of the students, and their observed laziness or lethargy in class. Per observation of the researcher, students attended classes irregularly during Ramadhan, and looked so tired and weak. Furthermore, the students have poor vocabulary knowledge and cannot understand some terms used in the questions.

The significant increase of the means during post-test in both groups implies that the respondents tried to answer the questions that called for higher order thinking skills. The higher significant value in the experimental group compared to the control group indicates that the group tried to apply their knowledge gained from the HOTS techniques to which they had been exposed. Furthermore, their thinking skills maybe more developed and improved compared to those of the control group who does not undergo any treatment at all. The respondents in the experimental group said that *"not all the lessons we have is easy, sometimes is difficult".* The significant difference in the mean gains between the groups indicates that the experimental group who used the HOTS techniques performed better on the HOTS questions compared to the control group. This implies that the HOTS techniques used by the researcher had a positive effect on the development of the critical thinking skills of the respondents. H. Ali, N. (respondent) says that *"I believe that these modules can help me to give more ideas advance in college. I feel happy in all activities; it is more challenging, more enjoyable and very hard like solving problems".*

The positive overall assessment of the respondents (experimental group) of the HOTS techniques and activities presented in the modules implies that the students want change in the teaching methods and are ready and eager for techniques that activate the learning process. It implies further that more challenging roles will help develop their critical thinking skills and that critical thinking is very important because it enables one to analyze, evaluate, and restructure his/her thinking. It does not involve simply acquisition and retention of information or the possession of a skill-set which one does not use regularly. Many of the respondent said, *"I know that modules in chemistry can help me when I go to college". "When time of activities, I feel so happy but when I have no answer I'm so sad".*

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