Available Online at ESci Journals
International Journal of Educational Studies
ISSN: 2312-458X (Online), 2312-4598 (Print)
http://www.escijournals.net/IJES

INTEGRATING GRAPHIC ORGANIZERS IN FACILITATING LEARNING CHEMISTRY

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A B S T R A C T

The study was intended to facilitate learning chemistry through the integration of graphic organizers (GOs). This study specifically determined the attitude toward chemistry and achievement of two groups of students under study. The study indicated that there is a significant difference between attitude toward chemistry of students in the experimental group before and after the experiment. The result of students' perception about GO, as teaching strategy and approach to teaching chemistry, indicated the rationale in this undertaking. All presentations used by the teacher in the class incorporating graphic organizers in identified formats such web diagram, flowchart-concept map, Venn diagram and pictorial graphics obtained a good and very good perception. Performance, on the other hand, indicated ultimate measure of GO's effectiveness in facilitating learning. This analysis implied that the experimental group performed significantly better than their counterparts in the control group with adjusted means scores of 47.45 and 39.11, respectively. Facilitating learning chemistry can be made through integrating graphic organizers. GO-based presentation solicited and indicated positive attitude from the students. Hence, the use of graphic organizers effect changes in behavioral dimensions of learning content for the better. GOs as conditioners can make students perform well and may seem to improve their attitude toward learning. GO is apparently indicating success as critical index of learning. It is recommended that GO be used by teachers to improve attitude and achievement of students.

Keywords: Facilitating learning, graphic organizers, visual learning, attitude toward chemistry, student performance.

INTRODUCTION

Learning to think and thinking to learn are two imperative skills essential to knowledge economy. One way to substantiate this is to make curriculum more facilitative to both students and teachers. According to Hall and Strangman (2002), integrating graphic organizers can be supportive of teacher's teaching and student learning. Graphic organizers (GOs) are visual displays that make information easier to understand and learn (Dye, 2000). It provides holistic representation of facts and concepts and their relationships within an organized frame. GOs have been applied across a range of curriculum subject areas and research-based applications have demonstrated their classroom utilization in the sciences, social studies, language arts, and mathematics. Operations such as mapping cause and effect, note taking, comparing and contrasting concepts, organizing problems and solutions, and relating information to main ideas or themes can be beneficial to many subject areas (Hall & Strangman, 2002). Nowadays, the GO appears to gain popularity among modern schools as it is used as a favorite teaching approach and as an accepted strategy in the classroom, as well. GO is the umbrella term for the various types of visual organizers and advance organizers. GOs exist in a variety of forms and are sometimes referred to as concept maps, story maps, advance diagrams, semantic maps, or concept diagrams. The acceptance and adoption of GOs to classroom across content areas and even across levels is an extract to the recommendation of numerous educational and cognitive psychology researchers showing that creating graphic representations to the students and by the students can enhance understanding of the content (Horton, Lovitt, and Bergerud, 1995).

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Chemistry is regarded 'abstract' or difficult science to some and if not attended properly by the teacher, this may create misconceptions as far as students' processing of content is concerned. Researcher's experience with the students various academic programs concretize this condition. Students really find difficulty in understanding content information, especially if the lesson and its presentation seem to be insufficient in practical substance, plus the fact that no innovation has been conceptualized by the teacher to invite students in the meaningful learning. The experience of the researcher, who is the teacher, being involved in tertiary instruction and being with students who find difficulty assimilating and processing science information, teacher should really invest employing innovative methodology appropriate to students' instructional needs. In light of all these, Chemistry teachers must consider instructional tools such as GOs which according to Jonassen (1998) are "*generalizable*" tools that can facilitate cognitive processing and communicate the logical structure of the instructional material (Jonassen, 1993).

Facilitating learning characterizes important element of the educative process, the learners – who are the focal point of teaching and learning. Through this emanates the constant consideration for the learner to the holistic perspective of education; be it in curriculum and instruction, in areas of assessment and evaluation, or in pedagogical practices. As this undertaking is revolving in the concept that chemistry teaching has to understand attitude of students and create environment so as to enhance performance of these students in the class, the use of teacher-made presentation can significantly elevate the dynamic process of chemistry learning as associated by most researchers about graphic organizers.

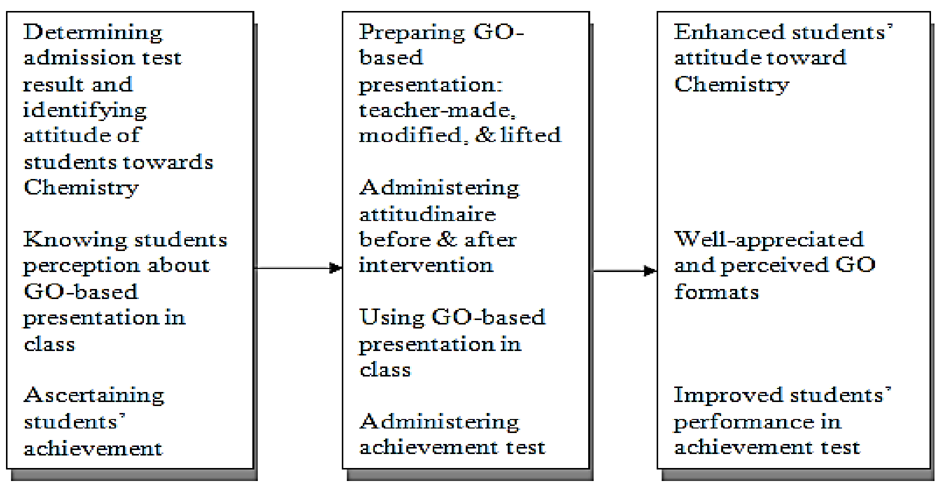

Figure 1. Research Paradigm of the Study

Figure 1 below specifies various variables of the study.

As indicated in the figure, the first tier presented research inputs, which are the variables of this undertaking: admission test result and attitude towards chemistry of the students, perception of the student in the use of graphic organizers, and academic performance or achievement of the students. The second tier deals about the critical processes entail in the research including (1) preparation of GO-based presentation, (2) administration of attitudinaire, (3) utilization of GO-based presentation in the class, and (4) administration of achievement test. The third tier of the paradigm present three (3) response variables which eventually devised rationale in the grounds being tested about graphic organizers and its powerful qualities as visual organizers. These are (1) enhancement of attitude toward Chemistry, (2) good perception about GO, and (3) improvement of academic performance (achievement) of students.

This paper attempted to test other graphic organizing tools beside concept map. As graphic organizer has been noted powerful visual tool then this undertaking gravitates in that construct to test the effect of GO-based presentation in learning chemistry in enhancing attitude and academic achievement of students.

The study was intended to facilitate learning environment with integration of graphic organizers (GOs) as learning tool on selected topics in Chemistry.

Specifically, it attempted to answer the following problems:

- Is there a significant difference in the attitude of students in the (a) experimental group exposed to GOs and (b) control group exposed to lecture-demonstration method before and after intervention?
- What is the perception of student exposed to lessons integrating graphic organizers in learning chemistry?
- How does the achievement test in chemistry of students in the experimental group differ from the control group?

This study focused in facilitating learning environment with integration of graphic organizers (GOs) as learning tool in selected topics in Chemistry. The GOs used in this study are clustered into web and Venn diagrams, flowchart, and pictorial form. Topics are chosen based on the content requirements as appeared in General Chemistry Course Syllabus and Information. The researcher, who is also the teacher of the class, gathered the necessary data and information in developing the lessons which was based in the course syllabus. These GOs were constructed, modified, or lifted from the internet and other materials such as books in preparation for actual classes. These GOs undergo validation by chemistry teachers and subject matter specialist/experts.

Two intact classes are involved in the study namely; the experimental and control groups. There were 68 participants in this study. Admission test result of these students is used as basis for the selection. The intact classes are heterogeneous.

Significant to the study is the preparation and consideration of the research instruments. For this undertaking, three (3) research instruments are used namely; (1) a 15-item attitudinnaire, (2) perception questionnaire, and (3) teacher-made test. The 15-item attitudinaire is patterned and taken from a validated 30-item Views about Science Survey (VASS). VASS probes student views in both scientific (structure and validity of scientific knowledge, and scientific methodology) and cognitive dimensions (learnability of science, reflective thinking, and personal relevance of science). This is however refined to conform to the requisite items of the study which included only the cognitive dimension of learning. The advisers validated the modified 15-item attitude questionnaire. Another instrument is the perception questionnaire. It is a researcher-developed questionnaire containing and outlining 20 GO-based presentations used in the class. The third questionnaire is the multiple-choice type of test consisting of 60 items and which covers related topics in chemistry to assess students' academic achievement. It is a teacher-constructed test whose reliability was determined through Kuder-Richardson formula 20.

This study was further delimited to these aspects which include the following: (1) mental ability of the students was not considered since class section is determined by first come first served enrolment system; (2) strict validation procedures to be undertaken in the instruments were not done; (3) contamination of information is one feature that the researcher may not control since two intact classes are within the same school. However, a measure to at least lessen its effect has been indicated.

METHODS

Research Design: This investigation opted both the descriptive and the quasi-experimental research designs. The descriptive method was used in depicting students' attitude towards chemistry, perception about GO and academic performance. This was also applied in presenting the results of the study. Contrastingly, the quasi-experimental method is employed to establish cause-and-effect relationship between variables of the study. According to Redfield, Sivin-Kachala & Schneiderman (2003), quasi-experimental designs must include at least one comparison group, they may or may not include a control group.

Preparing GOs
Validating GOs
Conducting attitude survey (before intervention)
Using GO-based presentation in the class for EG
Preparing achievement test
Validating (content) test
Administering test as FE
Conducting attitude survey (after intervention)
Assessing students perception about GO-based presentation of lessons in the classroom

Figure 2 indicates the research process that this study has undergone.

Research Instrument. Attitudinaire, perception questionnaire, and achievement test were utilized to gather pertinent data for the research. These instruments are made suitable in drawing together the requisite information needed for this research. *Participants of the Study*. Participants of this research are freshman students enrolled in the College of Hotel, Restaurant, and Tourism Management (CHRTM). Two intact classes were involved in the study namely; the experimental and control groups. Table 1 below presents data in setting the comparability of two groups of students.

Table 1. Students' college admission test (CAT) result.

Group	Mean	Mean Difference	*t*-value
Control	69.85	3.32	2.73*
Experimental	66.53		

* $p<0.05$.

The *t*-value is insignificant at the 0.05 level, implying that if the admission test can be an indicator of academic standing and mental ability, the two groups are not equal. Thus, students in the control group have better mean admission test scores, 69.85, than those in the experimental group, 66.53. This statistical result requires this parameter to be a covariate of achievement.

Data Gathering Procedure. The researcher, who is the teacher, started working with the study in successive phases. Phase 1 entailed preparation of graphic organizer-based presentations. GOs being used in the class refers to as GO collection can either be teacher-made, lifted or modified. Content validity of the materials integrating GOs was done by some teachers and thesis adviser.

Phase 2 was the experimentation phase which involved initially of class orientation and subsequent administration of attitudinaire and implementation of intervention to classes. Before the experiment, the teacher administered the attitudinaire to both group being tested. After subsequent exposure of students to the intervention, the same set of attitudinaire was asked to answer by the students. As significant part of this study, experimental group was asked to answer perception questionnaire after intervention.

Finally, phase 3 was about assessment of student learning through an achievement test. The two intact groups were evaluated through achievement test administered as final examinations of the course.

Data Analysis Procedure: The weighted arithmetic mean was used to describe typical behavior of the students from the attitudinaire instrument used.

The *t*-test was used to determine significant differences between the mean scores in attitude and achievement of students assessed before and after the experiments. The analysis of covariance (ANCOVA) was also performed to partial-out the effect students' attitude before experiment in comparing the students' attitude after experiment in the experimental and control groups. It is also used in order to analyze achievement test as indicator of change in performance in chemistry with admission test as covariate.

RESULTS AND DISCUSSION

Students' attitude toward chemistry: Initially, the attitude toward chemistry of students in the experimental group is revealed to be fair in most indicators. Such fair regard to science may be derived from high school science program. This however describes students' learnability, reflective thinking, and personal relevance of science as serious, teacher-dependent and is significant in everyday life respectively. Students primarily thought that chemistry is a hard and tough science to deal with and that serious learning is necessary. Teacher dependence is one quality revealed while their reflection about the lessons to learn about is weak. On the other hand, the attitude toward chemistry of students in the control group before the experiment is characterized to be better before intervention indicating more positive attitudes in most dimensions being considered as compared to the experimental group. After the experiment, *i.e*. exposing students to lecture-demonstration method, the same level of positive results in attitude is obtained in most indicators while remain to be agreeable.

Firstly, there is a significant difference between attitude toward chemistry of students in the experimental group before and after the experiment. The computed *t*-value of 8.51 gives a *p*-value of less than 0.05. Hence, it can be deduced that the students' attitude toward chemistry in the experimental group differs significantly before and after the experiment. Such indicated change of attitudes is characterized to be for the better after subsequently subjecting the class to lessons incorporating GOs. Thus, GO as teaching tool indicated effect on the way learning was made. The utilization of GO changed crucial behavior toward learning chemistry. GO makes meaning, and as an advanced organizer, it can make learning meaningful (Ausubel, 1969). Ausubel (1969) further expressed, that in order for "meaningful learning" to occur the individual must have established learning by determining if the information received is meaningful. If this information is meaningful, then the individual will process the information and this will strengthen his/her knowledge. Since positive result toward changing students' attitude is derived then each student experienced meaningful learning. From the orientation about chemistry requires serious efforts to be learned, it turned out that chemistry can be viewed as fun and exciting subject. Conclusively, such meaningful learning changed *learnability of science* among students. From this context, it can be deduced that the use of GO is tantamount to strategize. Secondly, determined significant difference is also accounted in the attitude of students in the control group, as computed *t*-value of 6.62 results to a *p*-value of less than 0.05. This means that the attitude of the students toward chemistry varies before and after the experiment.

Table 2. Mean score difference in attitude toward chemistry of student in the experimental and control groups before and after the experiment.

Group	Period of Experiment	Mean	Mean Difference	Computed *t*
Experimental	After	4.26	0.85	8.51*
	Before	3.41		
Control	After	4.40	0.57	6.62*
	Before	3.83		

* $p<0.05$; $t = 2.145$.

Lovitt (1994) however signified that both teacher-directed and student-directed approaches are considered to be best practices when working with appropriate approach based upon the purpose of the lessons and individual needs of the students. Consequently, to partial out the effect of students' attitude before the experiment, analysis of covariance (ANCOVA) had been applied using attitude after the experiment as covariate.

Table 3. ANCOVA Table - Mean difference of Students' attitude toward chemistry before experiment with attitude after experiment as covariate.

Sources	Adjusted Sum of Squares	df	Adjusted Mean Square	*F*-value
Grouping	0.495	1	0.495	7.336*
Error	4.348	65	0.067	

* $p<0.05$

Table 3 suggests that there exist significant difference in the attitude toward Chemistry between the two groups, based on the *p*-value less than 0.05. The attitude mean rating of the experimental group which is 4.26 is higher than the adjusted mean of control group which is 4.07, it can be inferred that students who are exposed to the GOs appear to have indicated more positive attitude than their counterparts in the control group. Hence, graphic organizers are valuable in any activity which requires the use of critical thinking. The use of these tools can generate excitement and enthusiasm toward learning. Therefore, graphic organizers appear to be a beneficial instructional strategy to support students in retaining learned information longer and to learn more effectively since behavioral dimensions have been set in place.

Students' perception about GO: With respect to identifying perception of students exposed to lessons integrating graphic organizers, *i.e.* for the experimental group, in learning chemistry, data presented below tabulated the results.

Students' perception is regarded significant in this paper. In this undertaking, it may provide explanation imperative to answering what caused change in the attitude of students in the experimental group after the experiment. There is an indication that graphic organizer-based presentations used in the class are all acceptable as all 20 collections included in the perception questionnaire obtained a good to very good rating in the ranges set by this research paper which is 3.51-5.00.

As far as web diagrams being utilized in the study are concerned, it appeared that the features of this organizer became students' most favorite GO as the highest composite mean of 4.58 (VG) is derived. Such attribute central to web diagram is that students felt the liberty to express ideas as encourage by the feature of this GO. In addition to this, students expressed vividly the created link of ideas hence it verified the assessment findings about learnability, *i.e.* serious learning to fun and exciting learning.

Another powerful graphic organizer and noted visual organizer-format helpful to the learners is the concept map (or flowchart). The perception about this group of GO is indicated in table 9 and obtained a composite mean of 4.41 (G). During implementation of this intervention, three (3) flowchart-concept maps are rated very good.

The indicator *In chemistry, it is important for me to learn ways to organize information and use it* emphasized the importance of flowcharting-concept mapping as an organizing and learning tool. It can be remembered that initially this statement belong to low mean-scored indicator and raise to rank 2 after exposing students to GO. The result may seem to reflect students' appreciation as they learn ways to organize information which is directed toward reflective thinking. Relatively previous studies linked congruence to the present findings. Houston (1993) has investigated on the effectiveness of concept mapping as an instructional tool and showed that concept mapping has generally positive effects on both students' achievement and attitudes. Johnson (1997) on the other hand, indicated that the effect of concept mapping on the memory retention and understanding can be explained in the way students were helped to remember and assimilate information (Johnson, 1997).

The ability of concept maps to present information in sequential and in hierarchical forms enable the student to draw correct ideas about and outline of text in his memory, thus, enhanced his ways of content acquisition. In this regards, active learning as well as generating and harnessing of conceptual knowledge become evident to students.

The use of Venn diagram as visual organizer has elevated students' learning of content and crystallizes the way topic has been presented on the perspective of students. It facilitated learning by depicting to the mind the crucial tasks of comparing and drawing the features of similarities and differences about the concept being discussed in the classroom. In overall, research in both educational theory and cognitive psychology tells us that visual learning is among the very best methods for teaching students of all ages how to think and how to learn (Marzano, Pickering, & Pollack, 2001). To reiterate, the comparative theme of GO helped learners to summarize learning, encourage elaboration, organize ideas and concretize abstract information. These, as mentioned, become evident as outcomes such as better content acquisition, and harnessed skills as such processing, analytical, and communication, were manifested. Motivating students can be best done through GO and invite them in meaningful learning.

Students' achievement in chemistry: Achievement as a research output in this undertaking takes a crucial standing. The achievement in chemistry of students in experimental group exposed to graphic organizers and students in the control group exposed to the lecture-discussion method is presented in the succeeding table.

Table 3. Summary of Results of Students' Perception in the Utilization of Graphic Organizers in Chemistry.

Type of graphic organizers	Number of presentations	Composite Mean	Verbal interpretation
Web diagram	2	4.58	Very good (VG)
Flowchart	12	4.41	Good (G)
Venn diagram	2	4.26	Good (G)
Pictorial formats	4	4.34	Good (G)

Table 4. ANCOVA Table – Achievement test in chemistry with admission test as covariate.

Sources	Adjusted Sum of Squares	df	Adjusted Mean Square	*F*-value
Grouping	0.495	1	0.495	7.336*
Error	4.348	65	0.067	

* $p<0.05$.

The comparison of students' achievement test results with admission test as the covariate shows significant difference at the 0.05 level of confidence. This analysis implies that the experimental group performed significantly better than their counterparts in the control group with adjusted means scores of 47.45 and 39.11, respectively. This result significantly conformed with previous research and theory about GO. Main points were indicated by Hartman (2000) who mentioned that GOs are useful as a conceptual communicative tool. As GO expounds processing of information, it allows operationalization of learned facts.

Novak and Gowin (1994) research about concept map, had revealed a positive result in students' achievement and thus, it is concluded that learning process had been facilitated. Guastello et al (2000), Ritchie & Volkl, (2000), and Willerman & Mac Harg (1991) focused on the same ground to facilitate learning of science content. From these studies indicated that the use of graphic organizers is an effective way to improve student comprehension and retention.

Integrating graphic organizers tend to elevate students' attitude toward learning chemistry. Katayama & Robinson (2000) used to mentioned that GO engages students in learning, resulting in encoding benefits. In the process, students made evident better learning output indicated by better scores in the achievement test. On this premise, features and themes of GO had served the purpose as the students revealed certain learning outcomes as active content acquisition, processing skills, critical thinking skills, and communication skills. Toward this finding is the ability of students to provide conceptual knowledge or framework for integrating new information and the encouragement of prediction. With respect to other skills, Web diagram allowed student to become spontaneous in expressing their thought, thus communication skills has been harnessed. Critical thinking skills are also developed reflective of students' ability to summarize learning, elaboration, and concretizing abstract information.

Achievement is the ultimate indicator of meaningful learning as far as this paper is concerned. It summarizes the interplay of variables such as student attitude toward learning chemistry and student perception about using GOs in the classroom. The utilization of graphic organizers appear to facilitate learning as students in experimental group reveal better scores compared to control group as indicated by t-test. It can be noted that this result can be explained by attitude shift brought about by GO.

CONCLUSIONS AND RECOMMENDATIONS

***Conclusions*. Based on the findings mentioned above, herewith are the conclusions drawn:** From that start point of learning chemistry, students' cognitive skills were enhanced. Different learning skills such as processing, critical thinking and communication skills became apparent. Therefore, interventions used by the teacher affect the attitude of the students towards learning chemistry and the use of GO constructed learnability, reflective thinking, as well as personal relevance of science in a way beneficial to the learner. Graphic organizer-based presentation solicited and indicated positive attitude to the students, hence, the use of graphic organizers effect change in behavioral dimensions of learning content for the better.

It is concluded students' perception on the use of GO-based presentation affirms the utilization of GO as pedagogy in facilitating learning. As more skills imperative to learning were exhibited, their perception of doing and learning about was transformed. Textual information (or the content) is advantageously learned with the use of graphics.

RECOMMENDATIONS

Facilitating learning chemistry can be made through integrating graphic organizers. This pedagogical input produces learning output of improving academic achievement of students. GO as effectors can make students perform well as achievement of students is said to be directly proportional to the teachers' translated strategy. GO promotes visual literacy and students are encouraged to create their own organizers reflective of the meaningful learning derived from the classroom. Graphic organizer as visual learning tool establishes meaningful learning. Through this research experience, reflection on pedagogical relationship translated into what the researcher call 'pedagogical equation' has been derived, i.e. "Teaching input is directly proportional to learning output, thus achievement, behavioral encouragement, and among others as desired learning output cannot be manifested without the teacher investing to an appropriate strategy that can be customized to the learner's situation". No amount of input, on the other hand, can create meaningful learning if teachers stagnate and will not harness his instructional skills.

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