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Conceptual Understanding Of Bsed Science Major Students Using The Molecular Models In Inorganic Chemistry

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ABSTRACT

Science is dynamic in nature and with the emerging trends in the world of teaching, the methodology of the teaching process must be innovative to adapt to the current trends in education. Chemistry is often regarded as a challenging subject, an observation that sometimes discourages learners from continuing with their studies. Students prefer learning in a classroom where active participation is greatly encouraged, and it is desirable that Science teachers introduce strategies that will enable students to think of solutions that address scientific knowledge construction. With these, the researcher was interested in finding alternative ways to help the BSED Science major students improve their conceptual understanding. The highlight of the study was the use of manipulative instructional materials that will make learning and understanding molecular geometry more concrete and enjoyable, anchored on the constructivism theory, which views learning as an active process that results from self-constructed meanings. The study utilized the quasi-experimental design, particularly the non-equivalent control group design. Based on the results, there is no noteworthy difference between the conceptual understanding of learning molecular geometry using molecular models and the lecture method, and both are effective teaching strategies for improving the conceptual understanding of the BSED Science major students.

Keywords: Conceptual understanding, Constructivism, Molecular geometry, Molecular models,

INTRODUCTION:

Science is dynamic in nature and with the advancement of technology and emerging trends that begin in the world of teaching, the methodology of the teaching process must be innovative to adapt to the current trends in education (Magtolis, 2013). Chemistry concepts can be ac quired and mastered, but often the motivation of the students to learn is just to gain good grades and pass the subject. As a major subject in higher education, Inorganic Chemistry is often regarded as a challenging subject, an observation that sometimes discourages learners from continuing with studies in chemistry (Sirhan, 2007). Students nowadays prefer learning in a classroom where active participation is greatly encouraged. With this, the need for alternative classroom teaching approaches rises. The teacher needs to adapt to the current trends of the students. They are then prompted to answer the needs of the science curriculum- the need for alternative approaches.

It is commonly observed that the application of appropriate media materials in teaching Inorganic Chemistry can significantly lessen certain difficulties and problems in the teaching of many courses and the use of alternative strategies may lead to significantly higher achievement of students when compared to the use of the traditional lecture method of teaching (Naboya, 2012). It is desirable that science teachers experience strategies that will enable students to think of solutions that address the construction of scientific knowledge (Souza & de Aguilar Jr., 2014). The teacher may use different approaches; however, the quality of instruction is evidenced by the amount of student engagement which is reflected by the amount of student learning that occurs (Magtolis, 2013).

Students nowadays are more active rather than passive learners. They perform actively when they are exposed to or given opportunities that will provide them the chance to construct their learning rather than just receive it. According to Molon (2011), the traditional lecture method is the most used method of instruction from the secondary to the tertiary level of education and is inclined into instruction in which the students are deprived of the opportunities to discover the knowledge they are taught for the teacher is the one who is, occasionally, is discussing and giving all the information. Traditional teaching with menial lectures is not enough since it does not stimulate the higher-order capabilities of students, or on some occasions, may be taught with the aid of two-dimensional representations that are static and not tangible. This, in turn, would make the learners passive in terms of conceptual knowledge acquisition.

With these dilemmas, the researcher was interested in finding alternative ways that will help both the teacher and the BSED Science major students in the teaching and learning process. Specifically, the highlight of the study was the use of manipulative instructional materials that will make learning and understanding molecular geometry more concrete and enjoyable. The researcher used the molecular models as mediators between theory and reality, as pointed out by Krell, Kruger, & zu Belzen (2012); and Chamizo (2011). These molecular models allowed the BSED Science major students to conceptualize how a molecule is structured. This approach to teaching Molecular Geometry in Inorganic Chemistry, as pointed out by Dori and Borak (2011), has been widespread for a relatively long time and has shown improvement in instruction in Science (Halloun, 1984). It involves the creation of three-dimensional representations of molecules in the form of geometrical shapes. In Science, models can be representations of ideas, concepts, or phenomena. Models can be tangible representations if they relate to the properties of the target (Ornek, 2008). Physical models of microscopic structures and concepts might better enable learners to understand microscopic structures that cannot be touched (Harris, Peck, Colton, Morries, Neto, & Kallio, 2009).

There are several models used in teaching Inorganic Chemistry, wherein, they are used to realize the spatial relationships between the atomic centers and the bonding electrons for the physical properties to be recognized (Ingham, 1988). In a ball-and-stick model type, all sticks (straws) are equal in length, while "real" molecular bond lengths are not (Dori & Barak, 2001). For this reason, the researcher used the clay-and-stick model to provide the opportunity for the students to manipulate the materials according to what they thought the concept is. The BSED Science major students are involved in the learning process because they crafted three-dimensional models that served as the basis for how the structure of molecules was perceived. In this method, the BSED Science major students were no longer on the sidelines idly listening to the teacher rather they were at the helm since the students were actively involved in the creation of the molecular models. This strategy made our students construct higher-order thinking capabilities. This study was different from the rest of the studies conducted on the use of models in teaching Science, but what was unique to this study was that the models were used in teaching molecular geometry.

The study was anchored on the Constructivism theory which viewed learning as an active process that results from self-constructed meanings (Piaget, 1955). This theory focuses on its core on the students' active role in their own learning as they build and organize their knowledge (D'Angelo et al., 2009). The constructivism theory was associated with the educational approach that promotes active learning on learning-by-doing. In this theory, students construct their conceptual understanding instead of just merely listening to them. Moreover, a student's conceptual understanding also plays a vital role in Inorganic chemistry education.

The study was also supported by project-based learning which is focused on using purposeful activity to guarantee the utilization of students' capabilities (Kilpatrick, 1918). Project-based learning's goal is to provide opportunities for students to become engaged in their own learning as they create meaningful artifacts (D'Angelo et al., 2009). In project-based learning, students learn better when they can construct concrete materials out of what they have learned. Molecular models could therefore be an alternative teaching technique to enhance BSED Science major students' conceptual understanding to enhance student learning of molecular geometry in Inorganic Chemistry.

1.1 Objectives of the Study

The study aimed to explore how the conceptual understanding of the BSED Science major students is affected by the teaching strategies used in teaching Molecular Geometry in Inorganic Chemistry specifically to:

1.1.1 determine the conceptual understanding of groups by looking at their mean scores: and

1.1.2 discuss the difference in the gain scores of the two groups

Materials and Methods

This part mentions the research design, respondents of the study, sampling design, instruments, procedure, and statistical treatment of the study.

Research Design

The study utilized the quasi-experimental design, particularly the non-equivalent control group design which according to McBurney & White (2013) suggested that the researcher must select participants in different conditions from pre-existing groups.

Respondents of the Study

The respondents of the study were Second-year BSED Science major students during the second semester of the school year 2018-2019. The two classes were composed of mixed Physical and Biological Sciences major students. One class has taken the said academic coursework on the MTh 9:00-12:00 schedule while the other group has taken it up TF 7:30-10:30 AM. They were enrolled in SCI-168L (inorganic Chemistry) during the second semester of the school year 2018-2019, taught by the researcher herself.

The two classes were considered as separate groups, control and experimental groups. Only those students who qualified in the inclusion criteria were considered as research respondents.

Sampling Design

The researcher used purposive sampling, particularly, criterion sampling, in choosing the respondents of the study. Criterion sampling is a type of purposive sampling that involves searching for cases or individuals who meet a certain criterion (Palys, 2008). Respondents of the study were selected using their Grade Point average (GPA) in all science subjects taken. Students with at least a 1.8 GPA in all their previous science subjects were selected as respondents. This was done to establish the same entry behavior. In this manner, being biased in sampling was avoided due to the equality of the students in terms of their academic performance. Students who did not qualify were still part of the class discussion. Two groups were utilized in this study particularly, the control and experimental groups. This was determined by a toss of a coin. The chances of being picked as either the control or experimental group are equal, for the odds of either the head or the tail landing face up is the same at 50% (Edkins, 2007). The head was assigned to the MTh class while the tail was assigned to the TF class. The side that landed up-head was considered the control group.

Research Instruments

The researcher utilized a researcher-made and adapted 30-item test for the pre and post-test. Items 1-10, 15-18, and 20-30 were made by the researcher while items 11-14, and 19-20 were adapted from the website of Southwestern University, Texas. These questions were validated by 3 Chemistry teachers who had more than 5 years of teaching experience in Chemistry. A pilot test was conducted on some students to determine the test's difficulty index and its items' discrimination index. Revisions, specifically on the changes in some alternatives, were made based on the results of the pilot test.

Research Procedure

The duration of the study (pre-test until post-test) lasted 5 meetings with an estimated period of 1 hour and 30 minutes for every meeting. During the first meeting, the researcher conducted the pre-test for the two control and experimental groups. The researcher kept the scores and the papers of the respondents. After the pre-test, the researcher conducted an intervention by means of teaching the two groups the topic of molecular geometry. In the second meeting, the researcher taught the BSED Science major students the topic of Lewis Structure which is a prerequisite to learning molecular geometry. In the third meeting, the researcher taught the two groups the topic of molecular geometry without the lone pairs. At the fourth meeting, the researcher discussed molecular geometry with lone pairs. On the fifth meeting, the researcher conducted a post-test to determine the learning gains of the students. All the scores and responses of the respondents were kept with the utmost confidentiality. It is important to note that all lessons discussed with both groups are the same except for the teaching strategies that the researcher used in teaching the lessons. Molecular models were utilized by the researcher in teaching the experimental group while the other group used no molecular models but were merely taught using the traditional lecture method. All the topics discussed by the researcher followed the lessons of Brown et al. (2012).

Statistical Treatment of the Study

The researcher used descriptive statistics for determining the level of conceptual understanding of the BSED Science major students, paired t-test for determining the significant difference of the difference between the student's pre-test and post-test scores, and the t-test independent sample for determining the difference between the gain scores of the two groups.

Results and Discussion

This presents the results and discussions of the identified objectives of the study. The presentation follows the enumerated objectives of the study. This study sought to find the conceptual understanding of BSED Science major students using molecular models in Inorganic Chemistry.

Conceptual Understanding of BSED Science Major Students

Table 1 below shows the conceptual understanding of the BSED Science major students as seen in their pre and post-test scores of the two groups – the experimental and control groups.

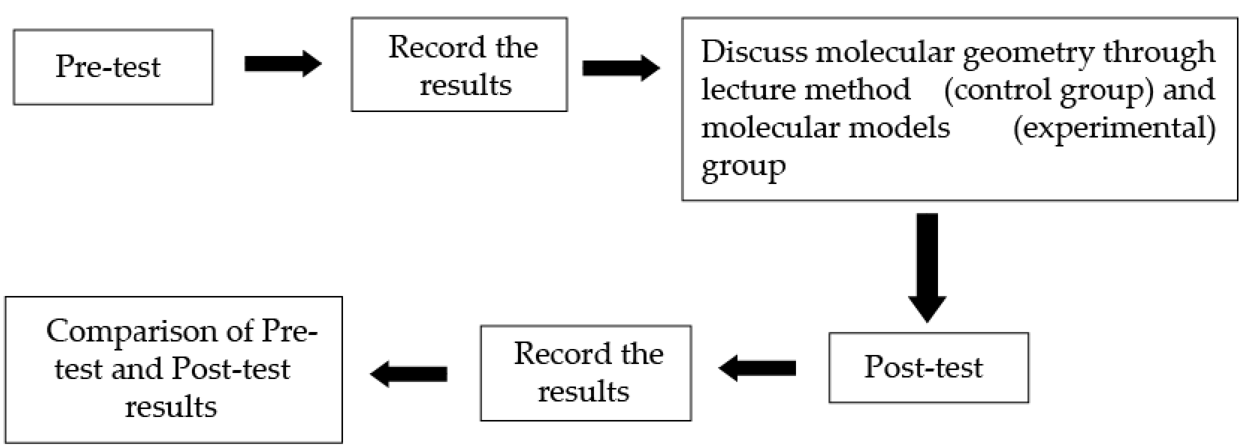

Figure 1.
The Flow of Activities in the Conduct of the Study

Group	Number of Respondents	Pre-test Mean Score	Post-test Mean Score
Experimental Group (Using Molecular Models)	30	15.25	25.75
Control group (Lecture method with no models)	30	16.67	25.08

Note: p-value<0.05=significant; p.value>0.05=not significant

Table 1.
Pre-test and Post-test Scores on the Conceptual Understanding of the Experimental and Control groups

Table 1 presents the pre-test and post-test scores of the two groups. It can be gleaned from the conceptual understanding that the Experimental group obtained a pre-test mean score of 15.25 and 25.75 post-test mean score, respectively, which indicates that the conceptual understanding of the experimental group's scores on the examination of the topics of molecular geometry increased after being exposed to the use of molecular models. It can also be seen from Table 1 that the Control group also obtained a pre-test mean score of 16.67 and 25.08 post-test mean score of 25.75 which also exhibited an increase in the conceptual understanding mean score using the lecture method without the use of molecular models.

With the results shown in Table 1, the researcher has found out that the BSED Science major students both in the experimental and control groups performed better based on the increased conceptual understanding mean scores after teaching the topics in molecular geometry in Inorganic Chemistry with the identified teaching strategies. As shown in Table 2, the pre-posttest mean differences between the experimental and control groups were 10.5 and 8.42, respectively. It can be gleaned from the table that there is a greater improvement in the conceptual understanding of the experimental group than that of the control group. The greater conceptual understanding improvement in the experimental group did not just happen by coincidence. Still, it was a product of the student's exposure to the molecular models, which is consistent with the findings of Magtolis (2013), Harris, Peck, Colton, Morries, Neto, & Kallio (2009), and Halloun (1984).

Group	Number of Respondents	Pre-test Mean Score	Post-test Mean Score
Experimental Group (Using Molecular Models)	30	15.25	25.75
Control group (Lecture method with no models)	30	16.67	25.08

Note: p-value<0.05=significant; p.value>0.05=not significant

Table 2.
The difference in the Gain Scores of the Experimental and Control groups

However, comparing the two groups pre-post-test differences, through the aid of t-test independent samples (t-test two samples in Microsoft Excel 2010) with an alpha level of 0.05, the researcher found out that the p-value of the comparison between the two groups gain scores is 0.478582. The p-value is greater than the set alpha value (0.478582>0.05) and with this, it can be interpreted as not significant. This implies that the students from the two groups performed equally well regardless of the teaching strategies they were exposed to and, thus, the null hypothesis – there is no significant difference between the scores of the students exposed to molecular models and students taught by using the lecture method is accepted.

Conclusion

Based on the findings of this research, the following conclusions are made:

1. There is no noteworthy difference between the conceptual understanding of the two teaching strategies - the molecular models and lecture method – in teaching Molecular Geometry in Inorganic Chemistry.
2. Molecular Models and the lecture method are both effective teaching strategies for improving the conceptual understanding of the BSED Science major students in teaching Molecular Geometry in Inorganic Chemistry.

References

Brown, T., LeMay, H.E., Murphy, C.J., Woodward, P.M. (2012). Chemistry: The central science. (12ed.). Illinois: Pearson Prentice Hall

Chamizo, J.A. (2011). A new definition of models and modeling in chemistry teaching. Retrieved fromhttp://www.joseantoniochamizo.com/pdf/A_New_definition_of_Models_and_Modeling_in_Chemistry.pdf https://doi.org/10.1007/s11191-011-9407-7

D'Angelo, C., Touchman, S., Clark, D., O'Donnell, A., Mayer, R., Dean, D., Hmelo-Silver, C. (2009). Constructivism. Retrieved from http://www.education.com/reference/article/constructivism

Dori, Y.J. & Barak, M. (2001). Virtual and physical molecular modeling: Fostering model perception and spatial understanding. Retrieved from http://www.ifets.info/journals/4_1/dori.html

Edkins, J. (2007). Tossing coins-theory. Retrieved from http://gwydir.demon.co.uk/jo/probability/info.htm

Halloun, I.A. (1984). The use of models in teaching Newtonian mechanics. Dissertation Abstracts International, 45 (060, 1807. Retrieved from http://adsabs.harvard.edu/abs/1984PhDT.......87H

Harris, M.A., Peck, R.F., Colton, S., Morris, J., Neto, E.C., & Kallio, J. (2009). A combination of hand-held models and computer imaging programs helps students answer oral questions about molecular structure and function: A controlled investigation of student learning. CBE Life Science Education, 8(1), 29-43. Retrieved from http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2649655/ https://doi.org/10.1187/cbe.08-07-0039

Ingham, A.M. (1988). Models in chemical education: An investigation into their uses. University of Surrey. Retrieved from http://epubs.surrey.ac.uk/771366/1/234561.pdf

Kilpatrick, W. H. (1918). The project method: The use of the purposeful act in the educative process. Retrieved from http://people.umass.edu/rwellman/Philosophy/Kilpatrick.pdf

Krell, M., D., & zu Belzen, A.U. (2012). Students' understanding of the purpose of models in different biological concepts. Retrieved from http://www.ijobed.com/2-2/Moritz-202.pdf.

Magtolis, J.M. (2013). The use of model making in teaching human organ system. JPAIR Multidisciplinary Journal, 11 (1), 49-67. https://doi.org/10.7719/jpair.v11i1.197

McBurney, D.H. & White, T.L. (2013). Research methods (9th ed.). Belmont, California: Wadsworth, Cengage Learning.

Molon, M.C. (2011). The effects of lecture discussion method with multimedia on the achievement of senior nursing students in Asian civilization (Unpublished doctoral dissertation). Leyte Normal University, Tacloban City

Naboya, M.D. (2012). Effect of modular approach on the level of achievement of students in inorganic chemistry (Unpublished doctoral dissertation. Eastern Visayas State University, Tacloban City.

Ornek, F. (2008). Models in science education: Applications of models in learning and teaching science. Retrieved from http://www.ijese.com/V3_N2_Ornek.pdf

Palys, T. (2008). Purposive sampling. In L.M. Given (Ed) The sage encyclopedia of qualitative research methods (pp.697-698). Sage: Los Angeles

Piaget, J. (1955). The construction of reality in the child. Retrieved from httpss://www.marxists.org/reference/subject/philosophy/works/fr/piaget2.htm.

Sirhan, Ghassan. (2007, June 6). Learning Difficulties in Chemistry: An overview. Journal of Turkish science education. Volume 4, Issue 2, Retrieved from http://www.tused.org

Souza, V. & de Aguilar, G. (2014). Modeling-based teaching in pre-service chemistry education: A historical-cultural approach. Retrieved from www.esera.org/.media/esera2013/Vinicius_Souza_10Feb2014.pdf