

Differentiated Instruction in General Chemistry

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Abstract:- The study aimed to determine the level of academic performance in General Chemistry using differentiated instruction. The quasi-experimental design was utilized and data were treated using mean and standard deviation, t-test for dependent sample and t-test for independent sample. The salient findings revealed that the level of academic performance of participants in Chemistry before instruction in experimental and control group was failed. After instruction in experimental and control group got the passing grade while experimental group got highly satisfactory. There was a significant differences in the pretest to the posttest in the experimental and control group in terms of their academic performance in Chemistry. The study concluded that the use of instructional material has enhanced the students level of achievement in Chemistry.

Keywords:- Chemistry, Teachers, Students, Instruction, Academic

I. INTRODUCTION

Chemistry is practically applied in all activities of daily existence and it gives integral understanding of the natural world around us. However, the predicament of chemistry subject has long garnered attention among education reformers. Thus, it is a challenge on the part of the teacher to think of appropriate teaching strategies that will suit student individual needs and learning styles.

In a traditional Chemistry classroom, a teacher presents information in a lecture style and then provides each student with the same laboratory investigation which is good only to those students who have good attention spans and have good logical and analytical thinking. Unfortunately, only few of the students are good in these aspects. According to Beaumont (2013), Chemistry subject like other academic subjects suffered much because students' diversity was not addressed. Thus, instruction based on the idea of one-size fits all is not appropriate.

The use of differentiated instruction is a viable and optimistic option for educators at all levels. The basic idea behind differentiation is to create lesson plans, projects, laboratory activities, assessments and learning environments to accommodate the individual readiness, interest and learning profile of each student (Collins, 2013).

The students' academic performance in Chemistry was low, thus the researcher inferred a survey to identify what factors might contribute to their low academic performance. These factors were the profile of the respondents which include their average number of hours in studying chemistry lessons at home, time schedule for chemistry, parent's educational attainment and monthly income. The learning styles of the students were determined. Findings of the survey showed the most of the students have kinesthetic and visual learning style. After knowing the result, the researcher suggested that differentiated instruction is the appropriate teaching strategy for them. Thus, to address the problem on low academic performance, the researcher conducted a quasi-experimental design using differentiated to find out if this strategy is really effective to her students.

The Use of Differentiated Instruction in Teaching Chemistry

There are significant aspects in teaching differentiated instruction in tertiary level. Ali (2013), opined that differentiated instruction overcomes deeper layers of learning of fast learner students while simultaneously structuring curriculum to support lower level students both identified and unidentified. Probably, the biggest hurdle to overcome is in the area of content knowledge and assessment. Because there are specific content and assessment requirements associated with every higher education course, the chosen teaching Chemistry and strategies must satisfy these specific content and assessment objectives. Seemingly at odds with these desired outcomes, differentiated instruction is teaching the learner's own personal meaning gained from the experience. Pairing students to allow for peer teaching is another method of reinforcing the strong students understanding of material while providing a struggling students with a peer instructor. This reciprocal learning style is another way for teachers to utilize the strengths in their classroom to create this differentiated instruction (Dewey, 2013).

There were selected students performing learning style in different topics of chemistry. There were seven group in differentiated instruction in chemistry which chose an activity in kinesthetic, audio and visual learning style in tertiary level. In Visual learning style, a teacher presents a power point and video presentation in which the students were answers the questions through multi-media presentation. In audio learning style, the students were keenly listening dictation of the teacher in their activity. While in Kinesthetic learning style the students

performed the activity prepared by their teacher in chemistry. The teacher motivates students that during lecture have hands on activity, video presentation and educational games related to the topics in chemistry (Freud, 2012).

Today's world is different from the one in which people lived just ten years ago. To be truly prepared for the 21st century, our students need schools that reflect those differences in teaching method as the years goes by they will become more updated with the technology (Doebler, 2011).

Today's students are digital and visual learners who thrive on collaboration through the use of computers, video equipment, audio equipment, digital cameras, and telephones. They can easily get new information coming from the social media so students are very much interested when the lessons presented by the teacher are more on video presentation or power point presentation because they will be able to see those images related to the topic (Anderson, 2012).

Teachers who differentiate are teachers who consider student learning preferences, abilities, styles, and interests. At the college level, teachers can implement a variety of processes to meet the learning attributes and characteristics of the diverse student population in their classrooms. The students will appreciate a teaching methods in the class in which they can be able to see and perform a topic presented by the teacher (Kleichmann, 2013).

According to Levy (2012) the core of differentiated instruction is flexibility in content, process, and product based on student strengths, needs, and learning styles.

Differentiated Instruction and Academic Performance in Teaching Chemistry

Differentiated instruction in College Learning is mostly an affective, dramatic, and emotional event that requires instruction that consumes the learner's whole being in the process. Gangi (2011) teachers were encouraged to present material differently according to a student's "learning style"—for example, visual, auditory, or kinesthetic. But while there have been studies that show students remember more when the same material is presented and reinforced in multiple ways, recent research reviews have found no evidence that individual students can be categorized as learning best through a single type of presentation.

Tomlinson (2017) argues that differentiation requires more than creating options for assignments or presenting content both graphically and with hands-on projects. Rather, to differentiate a unit on Rome, a teacher might consider both specific terms and overarching themes and concepts she wants students to learn, and offer a series of individual and group assignments of various levels of complexity to build those concepts and allow students to demonstrate their understanding in multiple ways, such as journal entries, oral presentations, creating costumes, and so on. In different parts of a unit

students may be working with students who share their interests or have different ones, and with students who are at the same or different ability levels.

Wormeli (2011) that teachers differentiate based on "learner profiles": "A learner profile is a set of observations about a student that includes any factor that affects his or her learning, including family dynamics, transiency rate, physical health, emotional health, and comfort with technology, leadership qualities, personal interests, and so much more." Thus, synthesized studies of more than 600 models of personalizing learning based on student interests and prior performance, and found them not much better than general classroom instruction for improving students' academic performance.

The differentiated instructional process begins with an assessment of the students' uses strategies such visual, audio and kinesthetic learning style. Differentiated and personalized instructional models have also evolved with technological advances, which make it easier to develop and monitor education plans for dozens of students at the same time. The influence of differentiation on school-level programs can be seen in "early warning systems" and student "dashboards" that aim to track individual student performance in real time, as well as initiatives in some schools to develop and monitor individualized learning plans with the student, teachers and parents (Doebler, 2011).

Smit & Humpert (2012) in recent years, individualized and differentiated systems of instruction have obtained an insufficient deal of attention in the educational literature. Often only practical concepts and implementation methods are presented; a review of these approaches on the effectiveness is given only in a few cases. The terms individualized teaching methods, differentiated and individualized instruction also have different meanings.

In differentiated instruction during lecture the teacher used a power presentation, video presentation and hands –on activity so the students will be attentive and more interested to the images presented in the class. The teacher advocates of hybrid education models, such as the "flipped classroom"—in which students watch lectures and read material at home and perform practice that would normally be homework during class time that have suggested and this could help the teachers differentiate by recording and archiving different lectures of the students could watch and rewatch as needed, and providing more one-on-one time during class. Beyond that, it is also equally important to preserve an insight of the opportunities and limitations of this teaching method (Sajol, 2013).

Nowadays, students are diverse learners with different skills of readiness, interest, learning profiles and academic achievements. This diversity of students necessitates a change in instructional practices which are based on a very equal population. Increasingly, teachers will inevitably have to face

the challenge of serving academically diverse, e.g. gifted students and low-performing students, in regular classroom. At the moment, teachers make only minor modifications to meet the needs of all students (Lumat, 2015).

According to Rojo (2013) implementing the use of differentiated instruction in the classrooms with regular Chemistry students is significant. Just as consumers that one-size fits-all won't work when buying a pair of jeans, educators know that one standard approach to teaching will not meet the needs of all over even most-students. Without an attempt to vary instruction to meet the individual needs of student, the curriculum is bound to bore some and battle others.

Differentiated instruction is the key to reaching all students. Differentiated instruction is a system that provides students with different avenues for acquiring course content so that all the students within a classroom can learn effectively, regardless of differences in ability and provides a framework for modifying curriculum and teaching strategies to complement the knowledge of readiness, areas of interest and learning profiles of each students (Beaumont, 2013).

Synthesis

The ideas of Doebler and McGuire underscored the importance of science strategies in the discussion of science concepts particularly those concepts in chemistry. These studies are similar to the present study because it determined the relationship of the academic achievement between the learning style of learners and teaching strategies to complement the knowledge readiness, areas of interest and learning profiles of each student.

On the other hand, the ideas of other authors mentioned that differentiated instruction premise students learn best when their teachers accommodate the differences of readiness, interests and learning profile of the students.

As shown in Figure 1, the central box is instruction since the study puts emphasis on how instruction in Chemistry will be carried out by the instructor.

Some insights emphasized that there is a direct link between students learner towards Chemistry and students outcomes. This was elaborated by Sajol (2013), Dewing (2013), Freud (2012), Carolan & Guinn, 2012); and (Dewey, 2013)], that students who perform better in a subject have more interests towards the subject. These studies have bearing with the present study since it looked into the students learning style towards Chemistry and academic performance [(Adesoji & Olatunbosun, 2008); (Jegede, 2007)].

II. THEORETICAL AND CONCEPTUAL FRAMEWORK

This study was anchored on the theory of multiple intelligences by Gardner (2012) which states that intelligence differentiates into specific (primarily sensory) 'modalities', rather than seeing intelligence as dominated by a single general ability. He articulated eight criteria for a behavior to be considered an intelligence and these are musical-rhythmic, visual-spatial, verbal linguistic, logical mathematical, bodily kinesthetic, interpersonal, intrapersonal, and naturalistic in which this learning styles focused into visual, kinesthetic and audio. This theory served as the basis of the study since differentiated instruction recognizes the diversity of learners.

Differentiated instruction is a way of teaching that provides students with a variety of entry points to access learning that is compatible with their way of understanding (Whitley, Gooderham, Duquette, Orders & Cousins, 2019.). It is a strategy that offers options and is a teaching technique that changes to meet the needs of all while still ensuring that everyone is achieving the same learning objective. It takes the stance that not all students are the same and as a result teaching and assessment methods must change to avoid teaching only to the average ones and the slow learners will be left behind. Moreover, according to Tomlinson (2017), students learn best when their teachers accommodate the differences in their readiness levels, interest and learning profiles.

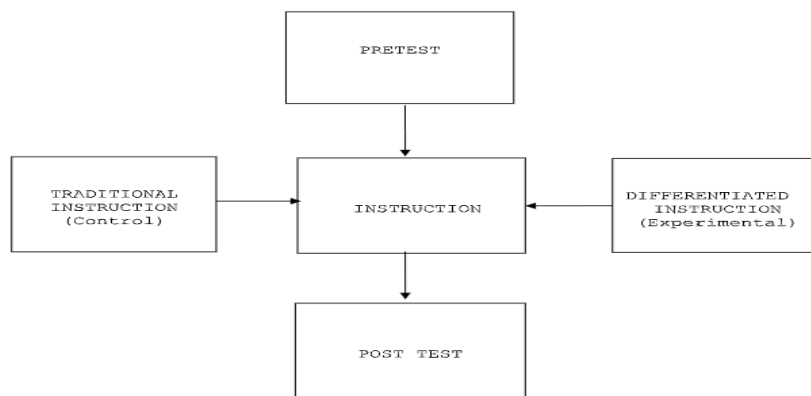


Figure 1.

Research Paradigm

The uppermost box is the pretest which is given to the students before the differentiated instruction conducted to the experimental group and traditional instruction to the control group. A posttest was given to both the experimental and control group to determine whether differentiated instruction is more effective in improving the academic performance of students in Chemistry.

Statement of the Problem

This study aimed to determine the level of academic performance in General Chemistry using differentiated instruction in the selected Agricultural Technology freshmen students of Surigao State College of Technology, Mainit Campus, School Year 2016 - 2017.

Specifically, it sought answers to the following questions:

1. What is the level of Academic performance of participants in Chemistry before and after instruction in the experimental and control group?
2. Is there a significant difference of pretest to the post test in the experimental and control group in terms of their academic performance in Chemistry?
3. Is the academic performance of the participants in chemistry in the experimental group better than that of the control group?

Hypotheses

At 0.05 level of significance it is hypothesized that:

H_{01} : There is no significant difference from the pretest to the post test in the experimental and control groups in terms of their academic performance in Chemistry.

Significance of the Study

The results of this study provided knowledge and information to the following:

School Administrators.

The findings may provide them with the needed insights and the exact information on the areas that must be improved which served as input in planning for seminars or workshops. Furthermore, the findings may help administrators in recommending appropriate teaching guide in teaching Chemistry subject.

Science Teachers.

The findings of this study may add up to the knowledge about the effectiveness of differentiated instruction in teaching General Chemistry. Through this knowledge the strategies can be recognized by Chemistry teachers thus enabling them to use teaching to improve students' achievement.

Students.

The study would provide each student the opportunity to appreciate the beauty and essence of Chemistry through the use of differentiated instruction since appropriate teaching techniques will help them understand the lesson easily.

Researchers.

This study may serve as reference for those who want to look into issues related to effectiveness of differentiated instruction in teaching chemistry. Recommendations offered may also be basis for further studies.

III. METHODS AND MATERIALS

This chapter presents the research design, research environment, participants, research instrument, ethics and data gathering procedure and data analysis employed in the course of the investigation.

Research Design

This study made use of quasi-experimental research design. This design is appropriate because it determines if the test scores of the control and experimental groups before and after instruction. In the same manner, this study also determined the significant difference from the pretest to the posttest in the experimental and control group in terms of their Academic performance in chemistry.

Research Environment

The location of the study was accessible because this was conducted at SSCT-Mainit Campus. This institution is one the branches of Surigao State College of Technology. The province located at Northern Mindanao. Some of the students enrolled in SSCT-Mainit Campus were 4 Ps founded by the government in which some of their parents do not have stable job. This study utilized two sections from Freshmen of Agricultural Technology students section A and section B.



Figure 2. Map of Surigao State College of Technology-Mainit Campus
 (https://vymaps.com/PH/Ssct-)Mainit-Campus-934216226745561)

The classroom of the two sections was fairly enough for the students belonging to each section. The classroom of students in General Chemistry was ventilated, fully furnished with two doors, the entrance and exit door. The green board was big with two ceiling fans, two fluorescent lights and four windows.

Participants

The classroom of the two sections was fairly enough for the students belonging to each section. The classroom of students in General Chemistry was ventilated, fully furnished with two doors, the entrance and exit door. The green board was big with two ceiling fans, two fluorescent lights and four windows.

The participants of the study were the 60 freshmen students of Surigao State College of Technology- Mainit Campus. They were composed of two sections namely: BATIA, and BAT IB. The school located at Magpayang, Mainit, Surigao del Norte and this is the only College found in Municipality of Mainit. The people lived in the place called Mainitnons where in Lake Mainit is the Fifth largest Lake in the Philippines. Table 1 shows the distribution of participants in this study.

Table 1. Distribution of Participants

Year & Section	N
I – BAT IA	30
I – BAT IB	30
Grand Total	60

Research Instrument

The instrument used in this study were Self-assessed VAK Learning Style Questionnaire which was adopted from Lucas and Corpuz (2009). Modification was done to fit the

need of the study. An achievement test in Chemistry was also used and it was adopted from the Science Curriculum of the Department of Education which is composed of 50 items.

Table 2. Grading System of Surigao State College of Technology

Grade	Equivalence	Qualitative Description
1.0	95-100 %	Excellent
1.5-1.1	90-94 %	Very good
2.0-1.6	85-89 %	Highly Satisfactory
2.5-2.1	80-84 %	Good
2.9-2.6	76-79 %	Satisfactory
3.0	75 %	Passing
5.0	Below 76%	Failed

Validity. The crafting of questionnaire was based on the Table of Specification (TOS).The questionnaire was shown to the adviser and panel members. The questionnaire was rectified based on the recommended suggestions given by the adviser and experts.

Reliability. The result of the run-rerun of the achievement test was tested for its reliability using Pearson r, the result was 0.97 which indicated that the instrument was reliable.

Ethics and Data Gathering Procedure

A letter of request was sent to Surigao State College of Technology-Main Campus (Appendix G) through the School Head requesting permission to conduct the study. Moreover a letter of permission addressed to the Tertiary Education (Appendix F) requesting the office to allow the researcher to use the questionnaire send from the said office.

Upon the provisions of approval from the concerned office, the experiment was conducted. Before the classes began, the pretest of the achievement test in Chemistry was given to the participants in the control and experimental groups. After the pretest, the VAK questionnaire was also administered to the participants in the experimental group in order to determine the learning styles of the participants for differentiated instruction.

The syllabi were prepared for each group. Participants in the control group were taught lessons in Chemistry using lecture method, that is, without differentiation. On the other hand, participants in the experimental group were taught Chemistry lessons using differentiated instruction. Differentiation was done by first grouping students based on the results of their learning style. They were grouped by four. Members in a group share a learning style; either they are all visual learners, all auditory learners, or kinesthetic learners.

Different activities were given to different learning styles. A visual-oriented activity was given to a group of visual learners per lesson. An audio-oriented activity was also given to a group of auditory learners per lesson. Also a psychomotor activity was given to a group of kinesthetic learners per lesson. Quizzes were given to both groups per topic.

After 3 months, the participants from both groups were given again the same achievement test they took in the pretest but this time serving as a posttest.

Data Analysis

To analyze the data of the study, the following statistical tools were employed;

Mean and Standard Deviation.

These were used to measure the achievement of the participants in Chemistry before and after instruction.

t-test for Dependent Sample.

This was used to measure the difference of Improvement of the control and experimental groups in their pretest and posttest.

t-test for Independent Sample.

This was utilized to measure the difference of performance of the control and experimental groups.

IV. RESULTS AND DISCUSSION

This chapter presents the results and discussions of the study based on the problems in Chapter 1.

Academic Performance Before and After Instruction

Table 2 presents the academic performance before and after instruction in terms of pretest and posttest of the control and experimental group.

Table 2. Academic Performance Before and After Instruction

Test	Mean	SD	Grade	Description
Control				
Pretest	13.57	5.44	3.9	Failed
Posttest	24.50	5.38	3.0	Passing
Experimental				
Pretest	13.27	3.46	3.9	Failed
Posttest	40.23	4.44	1.8	Highly Satisfactory

As shown in Table 2, the pretest result in the control group was 3.9 which means Failed while the posttest result was 3.0 which means Passing grade based on the grading system of Surigao State College of Technology. The pretest result in the experimental group was 3.9 which means Failed while the result was 1.8 which signifies highly satisfactory academic performance. The failed result in the academic performance in the pretest in the control and experimental group implies that the students have very little knowledge in chemistry concepts. The result in the posttest indicates that the experimental group performs better than the control group.

This finding supported by the idea of Levy (2012) that is teachers and educators all over the globe have long reached consensus over the fact that learners in any given class are characterized by a wide variety of individual differences. In other words, there is diversity of learners teachers should use varied learning strategies (Gangi, 2011).

Difference of Pretest and Posttest in Experimental and Control Group

Table 3 shows the difference on the academic performance of the students before and after instruction in General Chemistry.

Table 3. Difference on Academic Performance Before and After Instruction

Group	t-value	p-value	Decision	Interpretation
Control	16.17	4.8E-16	Rejected	Significant
Experimental	35.90	1.4E-25	Rejected	Significant

It can be gleaned on the Table above that the control group has a p-value of 4.8E-16 which is less than 0.05 thus, the null hypothesis is rejected. This means that the control group achieved better in the posttest than in the pretest. Furthermore, the experimental group shows a similar result. The p-value of 1.4E-25 is less than 0.05 and this results to the rejection of the null hypothesis. This indicates that the experimental group has a better achievement in the posttest than in the pretest. This finding implies that the students in the control and experimental groups learned from the lesson presented to them by their teacher.

The result implies that some students have a higher score in topic of matter because this is common in the surroundings. However, some of the lessons made them hard to internalize just like the naming of compounds, chemical formulas and stoichiometry. In experimental group the students would understand the topic based on the activity that they performed during the class.

Rojo (2013) opined that Chemistry subject will be easily understood in differentiated instruction since students undergo activities based on the students learning style. Moreover, Wansons (2012) mentioned that in the topic on matter students understand the lesson faster when hands-on activities will be conducted using concrete instructional materials.

Academic Performance of the Participants in Chemistry in the Experimental and Control Group

Table 4 reveals the difference in the mean gain of the participants in the control and experimental group.

Table 4. Difference on the Mean Gain of the Participants in the Control and Experimental Group

t-value	p-value	Decision	Interpretation
15.86	9.3E-23	Rejected	Significant

From Table 4, it can be discerned that the p-value is 9.3E-23 which is less than 0.05 which means that the null hypothesis is rejected. This indicates that there is a significant difference between the mean gains of the participants in the control and experimental group in general chemistry. The main gain in the experimental group is greater than that in the control group so the students in experimental group learn better than in the control group. This implies that differentiated instruction is an effective way of teaching general chemistry especially for students with varied learning styles.

Based on the result there was a higher main gain of the experimental rather than the control group in which the students performed an activity after the lessons of the teacher. In this 21st century the students really need to adopt and apply the technology so they need to use a power point presentation so that the students can see some images and examples to the lessons. Furthermore, the students must be in actual presentation so they can deepen their understanding on the topic. The teacher applies some laboratory activity in the lecture to improve student's learning.

Freud (2012) stated that students academic achievement improved when lessons are presented based on their learning styles. This can be attributed to the fact that, students are more interested to participate in the class activities and are eager to learn in the lesson presented to them.

V. CONCLUSION

The study aimed to determine the level of academic performance in General Chemistry using differentiated instruction. The participants of the study were the 60 freshmen students in Agricultural Technology who were enrolled in General Chemistry. The study utilized a quasi-experimental design. The data gathered were treated using mean and standard deviation, t-test for dependent sample and t-test for independent sample.

The salient findings are the following:

1. The students in the control and experimental group failed in the pretest. In the posttest the control group got a passing grade while the experimental group got highly satisfactory.
2. There is a significant difference in the academic performance of the students from the pretest to the posttest in the experimental and control group.
3. The academic performance of the participants in chemistry in the experimental group is better than that of the control group.

Based on the findings, the following conclusions were drawn:

1. The use of differentiated instructional material has enhanced the students level of achievement in Chemistry.
2. Students are engaged on different hands-on minds-on learning materials in which they improved from their pretest to the posttest in Chemistry.
3. Differentiated Instruction is an effective teaching strategy in Chemistry and it would help improve the level of academic performance of students with different learning styles.

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