Differentiated instruction using tiered lessons in inorganic chemistry

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The paradigm shift in teaching and learning strategies has been a great challenge to every educator at present. The modern approach to teaching is utilized in order to prepare students to meet the needs of every industry in the global context. As a part of the change, this study utilizes Differentiated Instruction using the Tiered as a methodological approach to learning. It determined the performance of the students on several measures and tested for the significant difference between the scores of the two groups. The respondents of this study were BS in Fisheries students from Don Mariano Marcos Memorial State University-South La Union Campus. Two groups were randomly chosen, assigned as experimental group (N=30) and control group (N=30), and were matched according to their IQ. Pre-test, posttest, chapter test, and rubric-assessed outputs were used to assess the respondents' performance. Frequency count, percentage, mean and t-test were employed to treat the data. The findings of the study showed significant improvement on the performance of the two groups in their posttest, chapter test, and in the outputs. The experimental group, however, performed better than the control group in the different performance measure. This implies that Differentiated instruction using Tiered Learning is an effective approach in the teaching and learning of Chemistry.

Keywords: teaching strategy, student centered, tiered lessons, student performance, projects

INTRODUCTION

One of the most important resources that organizations worldwide need at present is human resources. These are people that run machines and cater the need of every client in an organization. In order to utilize human resources effectively and efficiently, they should be equipped with knowledge, skills and ability that can be acquired through education. As mentioned by Vinluan (2007), one way of producing globally competitive graduates and uplifting the living conditions of every person in the country is through science education.

In the Philippine scenario, most families put more emphasis on education since they believe it is a way of changing for the better the lifestyle in the future. Indeed, as Fernandez (2002) stated, education occupies a vital role in the attainment of individual's dream. That is why the education agency in the country continually upgrades the quality of education offered by different institutions. Notwithstanding, are a lot of changes that give emphasis on designing curriculum and preparing instructional materials as has been implemented by the Commission on Higher Education (CHED). One of the changes that have been given attention to is the shift from a conventional method of teaching and learning to a modernized approach to classroom instruction. A significant part of the curriculum of many institutions is Science and Technology.

Meanwhile one subject in the general education curriculum of Higher Education Institutions (HEIs) is General and Inorganic Chemistry. In many HEIs, General and Inorganic Chemistry is enrolled by students taking up B. S. Biology, B. S. Mathematics, B. S. Psychology, B. S. Fisheries in their general education courses. Also, with students of teacher education program majoring in science courses. This subject indeed is very essential in preparing a student to face the highly-industrialized world.

Yet despite the importance of the subject Chemistry, students still do not realize it. It can be seen often times in the attitude of students towards the subject. Gallagher (2000) in Tadifa (2009) cited reasons why students do not take chemistry seriously: It is hard for them to see the significance of what is being taught; General chemistry concepts are taught and assessed in terms of facts, mathematical representations, and procedural knowledge without emphasizing conceptual understanding; Chemistry is presented in the most abstract or symbolic level. Most of the students feel that the abstract nature of chemistry concepts is always confined to the four corners of the classroom; and In traditional chemistry classroom settings, students rarely experience the source question of inquiry, critical and logical reasoning, the challenges or the surprises in real
life. Thus, students often interpret the subject as difficult as mentioned in the study of Cruz (2007). This can be attributed to the fact that the chalk-talk method in Chemistry instruction still remains a dominant approach in the classroom. Thus, students tend to be bored with the subject and lead to disinterest of the lesson. It is no wonder that the result sometimes is poor performance of students in the subject.

The above statement is one of the reasons why subject area coordinators as well as academic officers keep on reiterating their faculty members to vary their teaching approach. And one way to vary the conventional approach or teacher-centered approach to learning is through project method which is a student centered.

The differentiated instruction is one of the modern teaching and learning pedagogy in science instruction. In here, there is one objective set by the teacher that is achieved by students in different means. These means involves other fields such as literary compositions (song or a poem), visual and arts (painting), and construction and craftsmanship (making gadgets).

The aforementioned statements and other researches then motivated the researcher to determine the effectiveness of Differentiated Instruction using Tiered lessons in the performance of students enrolled in Chemistry. This time, students were given the chance to achieve the set objectives for the lesson on their own means. These mean includes poem or song writing, cartoon or comic strip making, and model making. Technicalities of the projects particularly the structure is likewise considered thus the researcher sought for the opinion of experts in creative writing, educational technology, and building designs.

All of these precipitating factors, therefore, formed the impetus for the conduct of this research.

Conceptual Framework

The foregoing study is supported by the following theories of teaching and learning namely John Dewey’s principle of teaching that the learner should be the center of learning, Constructivist theory of learning, Gardner’s theory of multiple intelligence and Vygotsky’s theory on the development of scientific concepts.

First, John Dewey’s principle of teaching states that the child should be the center of learning. He emphasizes the participation of the child in solving problem and that gaining insight and accumulating ideas can be effectively achieved through personal great efforts. John Dewey’s principle of learning states that child or the students learn effectively through the personal struggles in which they must investigate, accumulate ideas, process information, and put ideas into practical use. He emphasized that a learner learns best while doing and reflecting on the topics to be learned. The manipulation of objects allows the students to be the center of the teaching and learning process for they perform activities that allow them to comprehend better towards the subject matter.

Differentiated instruction is based on the idea that not all students are alike and they have multiple options for taking information and making sense of ideas. (Hall, 2002). The model of differentiated instruction requires teachers to be flexible in their approach to teaching and adjusting the curriculum and presentation of information to learners rather than expecting students to modify themselves for the curriculum. Classroom teaching is a blend of whole-class, group and individual instruction.

Differentiated Instruction is a teaching theory based on the premise that instructional approaches should vary and be adapted in relation to individual and diverse students in classrooms.

Tomlinson and Jarvis (2009) noted that Differentiation is an approach to curriculum and instruction that systematically takes student differences into account in designing opportunities for each student to engage with information and ideas and to develop essential skills. Differentiation provides a framework for responding to differences in students’ current and developing levels of readiness, their learning profiles, and their interests, to optimize the match between students and learning opportunities. These three dimensions of student difference can be addressed through adjustments to the content, process, products, and environments of student-learning, and each is justified by a research-based rationale.

Tiered instruction facilitates concept learning, building on skills and prior knowledge through the use of flexible grouping (Rogers, 1993 in Richard and Omdal, 2007). The tiering of lessons allows required skills to be gained at a learning rate better matched to the students’ instructional level. Tiered instruction is based on the existing skills and knowledge of the learners. Learner placement within a tiered level is based on a pre-assessment (formative assessment) score that measures the learners’ background knowledge and the level of the required skills for the content application. Tiered lessons support learners with low skills and minimal prior knowledge in gaining meaningful academic growth. It provides learners with high skills and above-average background knowledge the opportunity to go beyond the basics and add depth, complexity, and universal connections to the content. Tiering of instruction can be based on content, process, and/or product (Nordlund, 2003; Pierce & Adams, 2005).

Research Paradigm

This foregoing study has the framework that is illustrated in the form of paradigm. The inputs comprise the learning strategies or approaches to learning that are used by the researcher. These include the Traditional Approach to Learning (TAL) and the Differentiated Instruction using Tiered Lessons. These approaches to learning were utilized by the researcher in discussing selected topics in Chemistry. The process comprises of the student teacher-interaction as intervened by the different approaches to learning. The experimental group as well the control group will undergo pre-test, posttest, and chapter test to determine their performance. On the other hand, the experimental group prepared projects in the form of poem or song, comic strips, and models as their output. Their prepared projects are based on the tiered group they belong. On the part of the control group, instead of projects, students had quizzes, assignments, and seat works as their output.

Statement of the Problem

This study utilized Differentiated Instruction using Tiered lessons as a methodological approach of teaching in General and Inorganic Chemistry. Specifically, it sought answer to the following specific problems:
1. What is the performance of the students in Chemistry after being exposed to Differentiated Instruction using Tiered lessons and traditional approach in the:
   a. Pre-test
   b. Posttest
   c. Chapter test
   d. Students' outputs along:
      c.1. poem and song writing
      c.2. comic strip writing
      c.3. model making

2. Is there a significant difference between the experimental group and the control group in the pretest, posttest, and chapter test results?

Definition of Terms

The study investigates the effectiveness of input learning strategies on techniques done by the teacher in executing lesson. These include the traditional approach employing lectures, recitations, tests, and quizzes and the Differentiated learning that uses Tiered lessons where the objectives of the lessons were achieved in different ways involving poems/song writing, comic strip writing, and model making in explaining concepts in Inorganic Chemistry namely matter, atom, and elements. The concepts mentioned in the subject are the suggested topics covered by the students in Chemistry.

The teacher-learning process refers to the teacher-student interaction in the discussion of topics in General and Inorganic Chemistry using Tiered lessons in inorganic chemistry.
Differentiated Instruction using the tiered lessons that will be exposed to Experimental Group and lecture method that will be exposed to Control Group as intervention strategies.

The output is an Enhanced Syllabus in Inorganic Chemistry that is an instructional plan on how to conduct the topics in General and Inorganic Chemistry after determining the difference between the performance of the experimental and control group.

METHODOLOGY

Research Design

The method used in this study was the true experimental research design particularly the pretest-posttest control research design. The experimental method of research is a procedure involving controlled manipulation of conditions for the purpose of studying the relative effects of various treatments applied to members of a sample.

Source of Data

The primary source of data for this study involved students taking up Bachelor of Science in Fisheries at Don Mariano Marcos Memorial State University-South La Union Campus particularly at Institute of Fisheries. Specifically, the students were enrolled in General and Inorganic Chemistry (Chemistry 101). The levels of IQ were determined as superior, above average, average and below average. The assigning of group (Experimental and Control Group) is done through a fishbowl technique. Table 1 presents the distribution of the students categorized according to their IQ level.

<table>
<thead>
<tr>
<th>Levels of IQ</th>
<th>Experimental Group</th>
<th>Control Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Superior</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Above average</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>Average</td>
<td>24</td>
<td>24</td>
</tr>
<tr>
<td>Below Average</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td>30</td>
<td>30</td>
</tr>
</tbody>
</table>

The respondents are all regular first year students and are coming from different public institutions in nearby towns of La union as well as Pangasinan. The experimental group as well as the control group was handled by the same teacher (the researcher) to avoid the teacher factor in the performance of the students. The class using tiered lessons approach was conducted in the following procedures:

1. The teacher introduced the lesson. This time the mind of the students are stimulated to think what could be the lesson to be learned and the expected output.
2. The teacher utilized an example of output that explains the concepts of the lesson. For instance, the teacher presents a song to the class that reflects the concepts.
3. The classified the students in the experimental group according to types of learners. These types include linguistics learners, logical-mathematical learners, musical learners, bodily kinesthetic learners, and spatial visual learners. This was done by letting the students to take a test online to determine their strengths.

4. Selected students presented their projects such as reciting their poems.
5. The teacher assessed the student’s outputs and gave supplements to concepts that were not presented in the students’ output.

Moreover, the researcher conducted a chapter test both to the experimental and control group. This was done to prepare the respondents for the posttest particularly the experimental group for they are not exposed to pencil and paper test.

Meanwhile, the schedule of the two sections as respondents was consecutive. This was to avoid the time factor that may affect the experimental and control group of the study.

Instrumentation and Data Collection

The following are the data gathered and the corresponding instrumentation used for this study. The researcher included topics in General and Inorganic Chemistry for the experiment during the midterm of the first semester. The list of specific topics is listed below:

Matter
a. Classification of Matter
b. properties of Matter
c. Changes in Matter
d. States of Matter.

e. Energy and Matter

1 Law of Conservation of Energy

Atom
a. Atomic Theory
b. Subatomic Particles
c. Electron Configuration

Elements
a. Classification of Elements
b. Periodic Table

Performance. The performance of students was measured by the result of their pretest, posttest, chapter test, and their output.

1. Pre-test and Posttest. The researcher administered a pre-test and posttest to both the experimental and control groups. The test material was adopted from the study of Tadifa (2009). Prior to the administration of pre-test and posttest, the researcher determined the validity and reliability of the test instruments.

Validity of the Pretest-Posttest. According to Garret (1980), the content validity of a test may also be determined reliably by persons considered in the field. The content validity of the pretest-posttest was determined by the pooled judgment of five competent Chemistry instructors. The evaluators included five instructors from DMMSU SLUC Agoo La Union. Each instructor was given questionnaires and their response on the content validity of the pretest-posttest was tallied. Comments and suggestions were considered in the questionnaire and became the basis for further improvement of the test instruments.

The evaluation revealed that the test material prepared by the researcher has a weighted mean of 4.5 and has a descriptive equivalent of very high validity.

Chapter Test. The researcher gave a test to both the experimental and control groups after every chapter of the chosen topics in Chemistry 1. There were three
chapters of the subject matter, thus, the researcher prepared three chapter tests. The paper-and-pencil test prepared by the researcher was used to assess learning of the students throughout the experiments. The tests also give a chance for the experimental group to review for their posttest.

**Students' Output**

**Experimental Group** – The researcher gave a series of projects in relation to the topics in Chemistry as stated above. In this group, the researcher introduced the lesson, and then assigned projects to the students to strengthen their knowledge.

**Model making.** The students who are logical-mathematical learners were assigned to design a model to explain the topics. The students used raw materials found inside the campus and within their houses as in constructing their models.

Another topic from is the distribution of elements in the energy level and sublevels of an atom. The researcher introduced the topic on electron configuration, after which, the students were assigned to construct an electron mnemonic distribution.

The points given to the prepared models are based on a rubrics formulated by Cosares (2006).

**Making Comic strip.** The visual-spatial learners were assigned to a comic strip using their knowledge and imagination to animate the topics. The students, after the introduction of the instructor regarding the atomic theory, prepared a comic strip. The content of the comic strip includes the atomic theory proposed by John Dalton and the supporting or opposing ideas of the theories.

Another topic in the subject is the periodic trends. This topic discussed the pattern of the arrangement of the elements in the periodic table according to their properties. The students again prepared a comic strip for this topic, the content of which includes the trends of the periodic properties when reading the periodic table from left to right and top to bottom.

The comic strips prepared by the students were rated according to the adapted rubrics from the Cosares (2006).

**Song and Poem Writing.** Upon introducing the topics, the students who are musical and linguistics learners were assigned to composed a poem to elaborate the topics in the subject. Also, the musical learners are given the opportunity to give a tune to their compositions. The concepts of matter, its classifications, phases and the changes it undergoes was described by the students through a poem. Selected students were chosen to recite their poems for further processing of the lesson. The students were also asked to adopt a tune of their choice for the poem.

The students also composed songs about locating the elements in the periodic table. The contents of their compositions include the group number, period number, and the block where the elements can be located.

The assessment of their compositions was based on the adapted rubrics formulated by Cosares (2006).

**Traditional Approach to Learning** – A series of lecture was conducted to the control group using the traditional approach to learning and teaching, after which the students was assessed learning using the following paper-and-pencil tests.

**Assignments.** The researcher gave assignments to students to follow up students learning the classification of matter, properties of matter, and the changes it undergoes. The researcher assessed the students’ output using a prepared answer key.

**Quiz.** A series of questions was prepared as a quiz for the control group. This is to assess their learning in the listed topics covered by the researcher’s experiment.

**Recitation.** The researcher discussed the topics on periodic table, its history, how to locate elements, and periodic trends. Throughout the discussion, students were called to answer a question related to the topic. The students expressed their ideas verbally.

The number of points for this assessment was equal to the number of points assigned in the projects done by the experimental group. This is for the researcher to compare the gathered data from the different groups accurately.

**Data Analysis**

A pretest and a posttest were given to each group to assess their performance in the given topics in Chemistry. The result of the pre-test and posttest as well as the chapter tests of the students was treated using the frequency count. The mean scores were computed and each value is assigned a descriptive rating for.

Displayed below is the descriptive interpretation of the mean scores for the pre-test and posttests.

<table>
<thead>
<tr>
<th>Score Range</th>
<th>Descriptive Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 – 10</td>
<td>Poor</td>
</tr>
<tr>
<td>11 – 20</td>
<td>Fair</td>
</tr>
<tr>
<td>21 – 30</td>
<td>Satisfactory</td>
</tr>
<tr>
<td>31 – 40</td>
<td>Very Satisfactory</td>
</tr>
<tr>
<td>41 – 50</td>
<td>Outstanding</td>
</tr>
</tbody>
</table>

Chapter tests were also given to both experimental and control group. There were three chapters throughout the duration of the experiment thus the researcher prepared three chapter tests. Each test is composed of 50 points. Displayed below the descriptive equivalent of the score ranges for the chapter tests:

<table>
<thead>
<tr>
<th>Score Range</th>
<th>Descriptive rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 – 10</td>
<td>Poor</td>
</tr>
<tr>
<td>11 – 30</td>
<td>Fair</td>
</tr>
<tr>
<td>31 – 60</td>
<td>Satisfactory</td>
</tr>
<tr>
<td>61 – 90</td>
<td>Very Satisfactory</td>
</tr>
<tr>
<td>91 – 120</td>
<td>Outstanding</td>
</tr>
</tbody>
</table>

Moreover the outputs of the students in the experimental and controlled group were recorded to further determine their performance. To determine the scores of the students exposed to TAL, a 30-point score was assigned for assignment, 20 points was assigned for the quiz and 10 points was assigned to recitation. They had two quizzes, two assignments and two recitations during the duration of the study, thus the total accumulated points of 120.

For the projects of students exposed to the treatment, a rubric was used to assess students’ output. A twenty-point rubric scale was used for the model-making. There were two projects for the model making, thus, it has an overall total of 40 points. On the other hand, a ten-point rubric scale was used in poem and song writing. There were two sets of poems/song presented or a total of 20 points. A thirty-point rubric scale was used for the comic strip writing. There were
two projects presented in this category thus the overall total is 60 points. The descriptive equivalent of the scores of each project is shown on the next page.

On the other hand, the technical presentation of the projects was considered, thus, the researcher involved the expertise of English instructor, Civil Engineering instructor, and Technological Education instructor to assess the poem and song, models and comic strips respectively. The content of the projects was assessed by a Science instructor including the researcher herself. The overall total of the score for the students’ output in the experimental group is equal to 120 points. The accumulated scores of the students output is interpreted using the descriptive equivalents below.

**Rating Scale for the Poem/Song**

<table>
<thead>
<tr>
<th>Score Range</th>
<th>Descriptive Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.8 – 10.3</td>
<td>Exemplary</td>
</tr>
<tr>
<td>5.2 – 7.7</td>
<td>Accomplished</td>
</tr>
<tr>
<td>2.6 – 5.1</td>
<td>Developing</td>
</tr>
<tr>
<td>0 – 2.5</td>
<td>Beginning</td>
</tr>
</tbody>
</table>

**Rating Scale for the Comic Strips**

<table>
<thead>
<tr>
<th>Score Range</th>
<th>Descriptive Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>22.8 – 30.2</td>
<td>Exemplary</td>
</tr>
<tr>
<td>15.2 – 22.7</td>
<td>Accomplished</td>
</tr>
<tr>
<td>7.6 – 15.1</td>
<td>Developing</td>
</tr>
<tr>
<td>0 – 7.5</td>
<td>Beginning</td>
</tr>
</tbody>
</table>

**Rating Scale for the Model Making**

<table>
<thead>
<tr>
<th>Score Range</th>
<th>Descriptive Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>18.0 – 23.0</td>
<td>Exemplary</td>
</tr>
<tr>
<td>12.0 – 17.0</td>
<td>Accomplished</td>
</tr>
<tr>
<td>6.0 – 11.0</td>
<td>Developing</td>
</tr>
<tr>
<td>0 – 5.0</td>
<td>Beginning</td>
</tr>
</tbody>
</table>

**Rating Scale of the Mean Score on the Overall Students’ Output**

<table>
<thead>
<tr>
<th>Score Range</th>
<th>Descriptive Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>97 – 120</td>
<td>Outstanding</td>
</tr>
<tr>
<td>73 – 96</td>
<td>Very Satisfactory</td>
</tr>
<tr>
<td>49 – 72</td>
<td>Satisfactory</td>
</tr>
<tr>
<td>25 – 48</td>
<td>Fair</td>
</tr>
<tr>
<td>1 – 24</td>
<td>Poor</td>
</tr>
</tbody>
</table>

The significant difference between the student performance in the pre-test and post-test and in the chapter test was determined using the paired t-test.

**RESULTS AND DISCUSSION**

**Performance of Experimental Group**

Table 2 presents the performance of the experimental group in the pre-test, posttest, chapter tests.

![Table 2](https://via.placeholder.com/150)

The table below shows the experimental group indexing a mean score of 19.20 of out of 50 in the pre-test describe as “fair” performance. The result implies that the students have a very low comprehension of the topics discussed. However, the result of the pre-test served as a diagnosis on what concepts needed to be emphasized during the discussion.

On the other hand, the posttest of the experimental group has a mean score of 33.87 described as “very satisfactory”. The result of the posttest indicates an improvement of scores from the present since the topics have been already discussed prior to the conduct of test. Moreover, improvement of the performance could be attributed to the activities done by the students during the experiment. It was noted that the students in this group made projects. The manipulation of objects in making projects may have strengthened the retention of concepts in the students’ memory. The improvement of the performance of the students coincides with the result of the study of Perez (2009) wherein she exposed her experimental group to virtual field trip as an strategy to deliver the concepts in Science. She found out an improvement of the performance of the students exposed to virtual field trip describing it as very satisfactory and outstanding performance.

In the chapter test, the mean score of 102.1 out of 120 has a descriptive rating of “very satisfactory”.

**Performance of Experimental Group in the Outputs**

Table 3 on the next page presents the performance of the experimental group in terms of their outputs presented in the form of poem/song, comic strips, and models.

The table reveals the performance of the students according to the criteria used:

**Poem and Song Writing.** In terms of the ideas used in the compositions, the group got a mean score of 6.43 out of 10. In terms of organization of their thoughts, the students got a means score of 6.63. With regards to choice of words, the students got a mean score of 5.95 and a mean score of 6 for presentation. The mean score describe the experimental group as “accomplished” in composing poems and songs indicating a very good performance. This means that the students have original ideas and can arrange logical compositions. The words used in their compositions are descriptive words that try to create images and they present their ideas creatively using colored graphics as their background.

**Comic Strip Writing.** Table 3 shows that in terms of originality, the experimental group had a mean rating of 22.18 out of 30 indicating that the group is an “accomplished” group. With regard to the concepts and
Differentiated instruction using tiered lessons in inorganic chemistry

Table 3. Performance of Experimental Group Along the Outputs (Poem/song, Comic Strip, Models)

<table>
<thead>
<tr>
<th>Students' Output</th>
<th>Performance</th>
<th>Descriptive Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A. Poem or Song Composition</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ideas</td>
<td>6.43</td>
<td>Accomplished</td>
</tr>
<tr>
<td>Organization</td>
<td>6.63</td>
<td>Accomplished</td>
</tr>
<tr>
<td>Word Choice</td>
<td>5.95</td>
<td>Accomplished</td>
</tr>
<tr>
<td>Presentation</td>
<td>6.00</td>
<td>Accomplished</td>
</tr>
<tr>
<td>Overall mean</td>
<td>6.25</td>
<td>Accomplished</td>
</tr>
<tr>
<td><strong>B. Comic Strip</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Originality</td>
<td>22.18</td>
<td>Accomplished</td>
</tr>
<tr>
<td>Concepts</td>
<td>18.70</td>
<td>Accomplished</td>
</tr>
<tr>
<td>Illustrations</td>
<td>17.92</td>
<td>Accomplished</td>
</tr>
<tr>
<td>Color Harmony</td>
<td>12.48</td>
<td>Developing</td>
</tr>
<tr>
<td>Overall mean</td>
<td>17.82</td>
<td>Accomplished</td>
</tr>
<tr>
<td><strong>C. Model making</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Attractiveness</td>
<td>16.00</td>
<td>Accomplished</td>
</tr>
<tr>
<td>Originality</td>
<td>17.00</td>
<td>Accomplished</td>
</tr>
<tr>
<td>Graphic Relevance</td>
<td>16.48</td>
<td>Accomplished</td>
</tr>
<tr>
<td>Color Harmony</td>
<td>16.53</td>
<td>Accomplished</td>
</tr>
<tr>
<td>Overall mean</td>
<td>16.50</td>
<td>Accomplished</td>
</tr>
</tbody>
</table>

Table 4. Performance of Controlled Group

<table>
<thead>
<tr>
<th>Student Activity</th>
<th>Performance</th>
<th>Descriptive rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-test</td>
<td>18.6</td>
<td>F</td>
</tr>
<tr>
<td>Posttest</td>
<td>29.97</td>
<td>S</td>
</tr>
<tr>
<td>Chapter test</td>
<td>96.03</td>
<td>VS</td>
</tr>
</tbody>
</table>

Legend: F-Fair, S-Satisfactory, VS-Very Satisfactory

The remarkable performance of the students is similar to the finding of Eslabra (2003) where he observed a better performance of his students who underwent comic strip in their Science lessons.

Model-Making

The same table reveals that the students had a mean score of 18.70 and 17.92 which describes them as "accomplished" group of students. With regards to the color harmony, however, the students only got a mean score of 12.48 or "developing" stage. The result implies that the students have a remarkable performance on designing a comic strip. The remarkable performance of the students is similar to the finding of Eslabra, (2003) where he observed a better performance of his students who underwent comic strip in their Science lessons.

The result of the performance of the students along their outputs is closely similar to the findings of Cosares (2006), that the students who were exposed to poetry writing, comic strip writing and creative writing have result to accomplished and admirable performance. It can be concluded then that the accomplished and remarkable performance of the students can be observe and expected when they are given the opportunities to be creative in learning the concepts. Moreover, the remarkable performance of the students in Chemistry with their projects is closely related to the findings of Draper (2004), where students have more understanding their project as well as the concepts of the subject they are enrolled.

The overall performance of the students in the experimental group is accomplished which is similar to the result of the study of Masiong (2013) where he noted an improvement in the performance of his students using problem-based method in teaching physics.

Performance of the Control Group

The remarkable performance of the students in Chemistry with their projects is closely related to the findings of Draper (2004), where students have more understanding their project as well as the concepts of the subject they are enrolled.

The overall performance of the students in the experimental group is accomplished which is similar to the result of the study of Masiong (2013) where he noted an improvement in the performance of his students using problem-based method in teaching physics.

Table 4 as shown in the next page presents the performance of the control group along with their pre-test, posttest, chapter test and their outputs.

The pre-test mean score of 18.6 out of 50 describes the control group performing “fairly”. This is similar with the performance of the experimental group in the pretest revealing poor concept acquisition of different topics in Chemistry. These results of the pre-test then for the two groups served as a diagnostic test as a basis in implementing the experimental intervention plan.

Meanwhile, the posttest mean score of 29.97 out of 50 implies a “satisfactory” performance of the control group. Apparently, the result of the posttest of the control group shows an improvement from their pre-test performance. This may have been due to the fact that the topics covered have been discussed in the class and must have been retained on the minds of the students. This is also in accordance with the result of the posttest of the experimental group.

On the other hand, the chapter test mean score 96.03 interpreted as a “very satisfactory” shows that there is a minimum committed error and indicating a remarkable performance. This may have resulted from
students still having fresh minds in the retention of concepts given the short interval of discussion and tests. This chapter test result as a form of formative test coincides with the performance of the experimental group.

**Performance of the Control Group in their Outputs**

Table 5 presents the performance of the control group along their outputs in the form of quizzes, assignments, and recitations. The above table reveals the students having scored in their quizzes and assignment 14 out of 20 and 20.65 out of 30 respectively where both has a corresponding equivalent of “accomplished learners”. Their recitation performance, however, has a mean score of 5 out of 10 which means that the group is still in the developing stage.

It can be recalled that the quiz was given right immediately after the lecture thus students have a good retention of the concepts. Moreover, assignments are given to the students to be taken outside the classroom providing them with an opportunity to have access of better resources. On the other hand, recitations allow students to express themselves verbally and on the spot. The “developing” descriptive rating can be attributed to the fact that most students hardly express their ideas using the language of instruction. The above result is similar to the findings of Cosares (2006). His control group performed traditional assessment such as quizzes, assignments, and recitation and found out that the students’ performance on their assignment is “developing” and their recitation, “acceptable”. This is indicative satisfactory and fair performance when exposed to traditional assessment.

**Comparison of the Performance of the Control and Experimental Group along Pretest and Posttest**

Table 6 presents the test of significant difference conducted on the performance of the experimental group and control group along the pre-test and posttest. Reading the table horizontally, demonstrate the difference between the pre-test and the posttest of the experimental group and control group. The pre-test mean score of the experimental group is 19.2 while their posttest has an average of 33.87. The difference between the two mean scores is 14.67. It has a critical value of 2.045 and a computed t-value of 17.038. This result demonstrates a significant difference between the two scores at 0.05 level of significance. The significant difference of the two scores means that there is an improvement in the performance of the experimental group.

On the other hand, the pre-test and posttest of the control group has an average of 18.6 and 29.97 respectively. The two scores have a difference of 11.37. The computed t value is 11.744 while the critical value is 2.045. Since the computed t value is greater than the critical value, it was deduced that there is a significant difference between the two scores at 0.05 level of significance.

Both results imply that there is an improvement of the performance of the two groups. This may have been due to exposure of the students to the topics which were discussed to them. However, despite group performance revealing a significant difference between their respective pretest and posttest scores, the experimental groups performed better as revealed in their posttest mean scores of 33.87 and 29.97 respectively. The result implies that the Differentiated approach using tiered lessons led to a better performance of the experimental group. This can be attributed to exposure to Tiered lessons which provided an opportunity for students to manipulate objects, made them busy and developed their creativity and higher order thinking skills.

Reading the table vertically, experimental group and the control group have a mean score of 19.2 and 18.6 respectively. The two scores have a difference of 0.6. The computed t value is 0.542 which is lesser than the tabulated t value of 2.045. Hence, there is no significant difference on the performance of the two groups in their pre-test and it implies that the two groups are comparable. The result is similar to the findings of Ramirez (2007), wherein she assigned two groups as respondents of her study. Prior to the conduct of her study, she administered pre-test to both groups that the result revealed that the two groups were comparable in terms of their thinking skills at the onset of the study.

Meanwhile, the posttest of the experimental and control group revealed a mean score of 33.87 and 29.97 respectively. The two scores have a difference of 3.9. The computed t value is 2.999 while the tabulated t value is 2.045. The computed t value is greater than the t value.

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**Table 5. Performance of Control Group Along the Outputs (Quizzes, Assignments, Recitation)**

<table>
<thead>
<tr>
<th>Student Output</th>
<th>Mean</th>
<th>Descriptive Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quiz</td>
<td>14.00</td>
<td>Accomplished</td>
</tr>
<tr>
<td>Assignment</td>
<td>20.65</td>
<td>Accomplished</td>
</tr>
<tr>
<td>Recitation</td>
<td>5.00</td>
<td>Developing</td>
</tr>
</tbody>
</table>

**Table 6. T-test Result of the Performance of the Control and Experimental Group in the Pretest and Post Test**

<table>
<thead>
<tr>
<th>Group</th>
<th>Pre-test</th>
<th>Posttest</th>
<th>Diff</th>
<th>tc value</th>
<th>t-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exp't group</td>
<td>19.2</td>
<td>33.87</td>
<td>-14.67</td>
<td>17.038</td>
<td>2.045*</td>
</tr>
<tr>
<td>Control group</td>
<td>18.6</td>
<td>29.97</td>
<td>-11.37</td>
<td>11.744</td>
<td></td>
</tr>
<tr>
<td>Diff</td>
<td>0.6</td>
<td>3.9</td>
<td>0.542</td>
<td>2.999</td>
<td></td>
</tr>
<tr>
<td>tc value</td>
<td>2.045</td>
<td>2.045*</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Legend: * Significant at 0.05 Level
Table 7. Performance of the Two Groups in the Chapter Test

<table>
<thead>
<tr>
<th>Statistical range</th>
<th>Experimental Group (N=30)</th>
<th>Control Group (N=30)</th>
<th>Diff.</th>
<th>tc value</th>
<th>t-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>121 – 150</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2.121</td>
<td>2.045</td>
</tr>
<tr>
<td>91 – 120</td>
<td>27</td>
<td>18</td>
<td>9</td>
<td>2.045</td>
<td></td>
</tr>
<tr>
<td>81 – 90</td>
<td>3</td>
<td>12</td>
<td>9</td>
<td>2.045</td>
<td></td>
</tr>
<tr>
<td>61 – 60</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2.045</td>
<td></td>
</tr>
<tr>
<td>1 – 30</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2.045</td>
<td></td>
</tr>
</tbody>
</table>

Legend: VS = Very Satisfactory; S = Satisfactory

Table 8. T test of significant difference of the Students’ performance along with Chapter test

<table>
<thead>
<tr>
<th>Exp’l group</th>
<th>Control group</th>
<th>Diff.</th>
<th>tc value</th>
<th>t-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>102.1</td>
<td>96.03</td>
<td>6.07</td>
<td>2.121</td>
<td>2.045</td>
</tr>
</tbody>
</table>

hence, there is a significant difference of the two groups exists at 0.05 level of significance in favor of the experimental group. It can be noted from the result that the student exposed to Differentiated instruction using tiered lessons performs better than those student exposed to Traditional Approach to Learning.

The significant difference between the two scores from the posttest of the two groups in favor of the experimental group is similar to the findings of Masiong (2013) observing a significant difference between problem-based learning approach and Traditional approach to learning in favor of the former.

This finding is also similar to the result of the study of Stepsus (2005), wherein both groups in her experiments exhibited improvement in their post test, but the group exposed to videotapes instruction performed better than the group exposed to didactic teaching approach. Acar, B. and Tarihan, L. (2008), also mentioned a significant difference of the performance of the students favoring those who underwent case study approach in teaching and learning biology.

The finding is likewise similar to the findings of Marasigan (2007) in which the students performed better Chemistry achievement test after exposure to modified learning approach.

Moreover this result is consonant with the result of the study of Perez (2009) where she made use of virtual field trip as a strategy of teaching to her experimental group. She concluded that if students are exposed to non-traditional strategy such as virtual field trip, the achievement level of the students may improve.

This further implies that when a teachers explores non-conventional means in teaching and assessing learning, students perform better.

Performance of the Two Groups in the Chapter Test

Table 7 presents a comparison of the performance of the experimental group and the control group in the chapter test.

As can be shown from the table, there are 27 students or 90% of the 30 students in the experimental group which have a score within a 91-120 range described as “very satisfactory”. This number is greater than the frequency of the students in the control group of the same score range with only 18 students or 60% belonging to the very satisfactory range.

Moreover, there were 3 or 10% of the experimental group have a score within the range of 61-90 with a descriptive equivalent of satisfactory performance. This frequency is lesser than the control group where 12 or 40% of the group belong to the range with satisfactory rating.

The result implies that more students in the experimental group performed better in their chapter test than the students in the control group. It can be noted that the students in the experimental group showed better understanding towards the concepts through their making of projects. The projects then, allowed students to comprehend the subject matter and understand the concepts better. This is similar to the findings of the study of Barak and Dori, (2004) where their students who participated in the IT-enhanced PBL performed significantly better than their control classmates not only on their posttest but also on their course final examination.

This result is closely similar to the findings of Handa (2000) explaining that Practical Problem Solving Tasks promoted meaningful retention as evidenced by significant higher meaningful retention test mean score of the students exposed to practical problem solving tasks. This only means that when students perform practical problem solving and is involved in meaningful projects; concepts are better retained on their minds easily.

Comparison of the Control Group and Experimental Group’s Performance in the Chapter Test

Table 8 presents the test of significant difference of the performance of the experimental group and control group in the chapter test.

As can be seen in the table, the mean score of experimental group is equal to 102.1 which is greater than the mean score of the control group which is equal to 96.03. The difference of the two scores is 6.07. The computed t value of 2.121 is greater than the tabulated t value of 2.045 implying a no significant difference of the performance of the students along with chapter test. This means that a significant difference of the two scores exists in favor of the experimental group.

The result is parallel to the result of the study of Handa (2000) noting a significant difference in the meaningful retention of conceptual understanding of both students after a month of intervention in favor of the practical
problem solving task group. He found out in his study that the students who performed practical problem solving tasks have favorable scores in their achievement tests.

Comparison of the Performance of the Control and Experimental Group in Their Outputs

Table 9 shows comparison of the performance of the two groups along with their outputs namely poem/song writing, comic strip sketching, and model-making for the experimental group and quizzes, assignments, and recitations for the control group.

The table reveals that there are 3 out of 30 or 10% of the students from the experimental group fall under the score range of 97–120 described as outstanding, 20 or 66.67% are within the score range of 73–96 described as very satisfactory, and 7 or 23.33% are within the score range of 49–72 described as satisfactory. With respect to the control group, 20 out of 30 or 66.67% of the students are within the score range of 73–96 (DR= very satisfactory), and 10 or 33.33% are within the score range of 49–72 (DR= Satisfactory).

While the results indicate a similar performance of the students in the two groups based on the distribution, the difference observed between the two groups still indicates a better performance in favor of the experimental group. This indicates that more students in the experimental group have learned better while performing a real experience throughout the discussion of the concepts in Chemistry. These students learned best while doing projects that are related to the concepts taught. The observed better performance of the experimental group coincides with the result of the study of Mendoza (2000), where the students learned better from activities emphasizing real experiences. This simply means that when students perform experience-based activities in classes, they could comprehend well the concepts taught. Likewise, the better performance is also similar to the findings of Bal, (2016) where it was revealed that the differentiated teaching approach in a algebra lesson increases student achievement, and students showed positive cognitive and affective developments.

Summary

This study utilized differentiated learning using tiered lessons in Inorganic Chemistry. Specifically, it determined the 1) performance of students in Chemistry as exposed to differentiated instruction using Tiered Lessons and traditional approach measured in terms of a) Pre-test, b) Posttest, c) Chapter test, and d) Students’ Outputs namely poem or song writing, model-making, and making comic strip (for experimental group) and assignments, recitations, and quizzes (for the control group); 2) significant difference between the experimental group and the control group in the pre-test, posttest, and chapter test results; 3) proposed an enhancement in the syllabus in Chemistry based on the result of the study.

The study employed the true experimental research design particularly the pretest-posttest control research design. Sixty students from Institute of Fisheries of DMMMSU-SLUC are considered as respondents of this study.

A pre-test and post-test was given to the respondents to assess their performance. The test instruments used were items validated by five experts in the field of Chemistry and was subjected to reliability test. Moreover, the performance of the students was measured using chapter test and the students' output.

The data gathered were treated using frequency, percentage, mean, and t-test.

Findings

The following are the salient findings of this study.
1. Performance of students
   a. The pre-test mean score of the experimental group is 19.2 while the pre-test mean score of the control group is 18.6. Both scores have a descriptive equivalent of fair performance.
   b. The posttest mean score of the experimental group is 33.87 while that of the control group is 29.97. Such performance is described as very satisfactory and satisfactory, respectively.
   c. The chapter test of the experimental group has a mean score of 102.1 while the mean score of the control group is 96.03. Both scores indicate very satisfactory performance.
   d. The outputs of the experimental group have a mean score of 87.87 describe as very satisfactory performance. The poem or song has a mean score of 6.25 (DR = Accomplished). The comic strip has a mean score of 17.82 (DR = Accomplished). The mean score of the models prepared by the students is equivalent to 16.50 (DR = Accomplished).
   e. The output of the students in the control group is equivalent to 80.2 described as very satisfactory performance. The quizzes of the students have a mean score of 14 (DR = Accomplished). The assignments submitted by students have a mean score of 21.65 (DR = Accomplished). The recitations of the students have a mean score of 5.00 (DR = Developing).
   f. The pre-test of the Experimental group has a mean score of 19.2 out of 50 while the post test is 33.87 out of 50. There is a significant difference between the two
score indicating an improvement of the performance of the students from the pre-test to posttest.

There are 27 or 90% of the students from the experimental group have a mean score within the score range of 91 – 120 with respect to their chapter test. The students are rated with very satisfactory. On the other hand, there are 3 or 10% of students have a score within a range of 61-90 with a rating of satisfactory. This implies that most students perform very satisfactory.

There are 18 or 60% out of 30 students have a score within a range of 91-120 with a rating of very satisfactory. There are 12 or 40% out of 30 students have a score within a range of 61 – 90.

The pre-test of the control group is 18.6 with a descriptive rating of fair while their posttest is 29.97 with a descriptive rating of satisfactory. There is a significant difference between the scores of the group indicating an improvement by the students from their pre-test.

2. Test of Significant difference in the Performance of the Control and Experimental Group

a. The computed t-value (t=0.542) is lesser than the tabulated t-value (t=2.045) in pre-test of the control and experimental group. The no significant difference between the two scores implies that the two groups are comparable in terms of the level of IQ.

b. The computed t-value (2.999) is higher that the tabulated value 2.045 in the posttest of the experimental and control group. The significant difference between the two scores favored the experimental group.

c. The computed t-value (2.121) is higher than the tabulated value (2.045) in the chapter test of the experimental and control group. There is a significant difference between the two scores favored the experimental group.

d. There are 3 out of 30 students from the experimental group who scored within the range of 97-120 described as outstanding while no students however scored such in the control group. Both, experimental and the control group, have 20 out of 30 students who scored within 73–96 ranged described as very satisfactory. Within the score range of 49–72, there are 7 in the experimental group who fell under the bracket while there are 10 students from the control group who fell in the said bracket. The result indicates a better performance in favor of the experimental group.

Conclusion

Based on the findings of this study, the following conclusions are drawn.

The students in the experimental group performed fair in their pre-test and very satisfactory on their posttest, chapter test and in their outputs (poem or song, comic strip, models). On the other hand, the control group performed fair in their pre-test and very satisfactory in their posttest and chapter test. Although the student output of the control group is very satisfactory, this is only true to the quizzes and assignment because the recitation is only satisfactory. Furthermore there is an observed improvement of the scores of the two groups in their pre-test and posttest as a result of the discussion done.

There is a significant difference between the scores of the experimental group and the control group along the pre-test, posttest and chapter test which implies a better performance in favor of the experimental group. On the other hand, there are more students from the experimental group who performed better compared to the control group with respect to their outputs.

From the result of the study, an enhanced syllabus for Inorganic Chemistry is developed and proposed.

Recommendations

Based on the conclusions drawn from this study, the following recommendations are provided:

1. Instructors in any field must utilize the differentiated learning particularly tiered lessons as an approach to learning for this is an effective means to allow learning to take place among students.

2. There should be a collaboration of the instructor with other experts in terms of the technicalities of the projects submitted by the students for a valid and more reliable assessment. Moreover, the suggestions and comments given by experts should be considered as a basis for improvement.

3. With respect to instructional planning, syllabi should be enhanced incorporating Performance-based assessments because most students can learn better while manipulating things in relation to their subject matter.

4. Further study on Differentiated Instruction Using Tiered Lessons is also recommended to be undertaken considering this time students working as a group and considering active role of students in the assessment of projects.

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