



## Process Oriented Guided Inquiry Learning: An Effective Approach in Enhancing Students' Academic Performance

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**Abstract:** This study investigated the level of performance of the students who were exposed to traditional method and POGIL method of teaching. This also aimed to determine if there is a significant difference between students' exposed to traditional method of instruction and students' exposed to guided inquiry instruction (POGIL) in terms of their academic performance in particulate nature of matter as measured in the post-test. One intact class (N=41) from the SSC – III students of Lala National High School was utilized in this study who were divided and distributed randomly to the control group and experimental group. Traditional method was utilized for the control group while POGIL method was utilized for the experimental group. The Particulate Nature of Matter Assessment version 2 was used in data gathering which was developed by Yezierski and Birk (2006). The gathered data was statistically treated using frequency and percentage distribution, Levene's Test for Homogeneity and Analysis of Covariance. Result of the study revealed that POGIL method has improved students' level of performance more than the Traditional teaching method. There is also a significant difference on the performance of the students in both groups,  $F(1,38)=43.02$ ,  $p<0.05$ ,  $\eta^2=0.53$ . Adjusted mean scores suggest that the use of POGIL instruction ( $M=16.53$ , S.E. = 0.393) is significantly better in enhancing students' academic performance compared with the traditional method ( $M=12.92$ , S.E. = 0.384). Thus, teachers are urged to use POGIL method in their science lessons.

**Key Words:** particulate nature of matter; guided inquiry, academic performance; traditional method

## 1. INTRODUCTION

### 1.1 Background of the Study

Particulate Nature of Matter (PNM) is considered as the underlying foundation of chemistry. In fact, Amiot (2008) stressed that without appropriate understanding of the PNM, a learner faces great difficulty in mastering complex concepts and skill in chemistry.

However, despite of its importance, several studies have recorded students' alternative conceptions on PNM (Anderson, 1990; Boz & Boz, 2008; Johnson, 2000; Harrison & Treagust, 2002).

Results of these studies revealed that the meaning of the term particles, the nature and characteristics of particles, the nature of space between particles, behaviour of particles in different states of matter, the size of molecules, and change in the arrangement of the particles during the phase change and chemical processes are the main problematic concepts for the students to understand.

According to Hesse and Anderson (1992), these problems arise due to the abstract nature of chemistry in which the teachers failed to address. Colburn (2009) and Uce (2009) noted that chemistry teachers are aware that students often struggle with the abstract concepts they are teaching, and yet, pedagogy in most chemistry classrooms does not address the students' needs to develop appropriate



mental models of abstract chemistry concepts. To resolve the issue, students must have the ability to work with abstract concepts (Marais & Combrinck, 2009) and to do this, they must be able to use and comprehend three levels of representation: macroscopic, sub-microscopic, and symbolic representations (Chandrasegaran & Treagust, 2009).

More so, for the students to have a complete grasp of the abstract concepts of chemistry, teachers must choose the appropriate teaching method. In this case, a guided inquiry is appropriate. According to Nadelson (2009), guided inquiry learning holds great promise in assisting students to learn science free of alternative conceptions. Furthermore, this method assists students as they connect their understandings of macroscopic and microscopic chemical phenomena to their symbolic representations (Hansen, 2006). Thus, in this study, the researcher utilized the Process Oriented Guided Inquiry Learning (POGIL) in enhancing students' academic performance in particulate nature of matter (PNM).

Process Oriented Guided Inquiry Learning (POGIL) is a research-based, student-centered philosophy and science pedagogy in which students work in small groups to engage in guided inquiry using carefully designed materials that direct and guide students to build and rebuild their chemistry knowledge (Boniface, 2009; Hanson & Apple, 2004; Moog & Spencer, 2008). This simultaneously teaches both content and key process skills of science. POGIL activities focus on core concepts and processes of science as it encourages and fosters a deep understanding of the course material while developing higher-order thinking skills.

### **1.2 Research Problem**

The main purpose of this study was to determine the effect of Process Oriented Guided Inquiry Learning (POGIL) on students' academic performance on some aspects of particulate nature of matter. Specifically, this study sought to answer the following questions:

- 1.2.1 What is the level of performance of the students in the control and

experimental groups as measured in the pretest and posttest results?

- 1.2.2 Is there a significant difference between students' exposed to traditional method of instruction and students' exposed to guided inquiry instruction (POGIL) in terms of their academic performance in particulate nature of matter as measured in the posttest?

## **2. METHODOLOGY**

### **2.1 Research Design**

A pre-test-post-test randomized control group design was employed in this study to determine the effect of Process Oriented Guided Inquiry Learning (POGIL) on students' academic performance on particulate nature of matter. One intact class of third year Special Science Class (N=41) of Lala National High, Maranding, Lala, Lanao del Norte was divided randomly into two groups: control group and experimental group. The control group was exposed to the lecture method of teaching while the experimental group was exposed to POGIL method. A pre-test (ParNoMA2) was administered to each group prior to instruction. After instruction, each group was given a post-test using the same instrument.

The pre-test and post-test results of the two groups in this study were compared using Analysis of Covariance (ANCOVA). This was chosen to compare the control and experimental groups in order to control for the possible existence of an extraneous variable that could differ between the control and experimental groups. The used of ANCOVA adjusted the mean scores of the control and experimental groups for differences between the groups that existed.

### **2.2 Subjects**

The subjects of this study were taken from one intact class of third year Special Science Class students (N=41). The class was randomly divided into two groups categorized as follows: Advanced,

Proficient, Approaching Proficiency, Developing, and Beginning. Table 1 shows the distribution of the subjects in in each group.

Table 1  
Distribution of Subjects in the Study

Category	Experimental Group		Control Group	
	f	%	f	%
Advanced	1	5	1	4
Proficient	10	50	10	48
Approaching Proficiency	9	45	10	48
Total	20	100	21	100

### 2.3 Instrument

This study used the Particulate Nature of Matter Assessment Version 2 (ParNoMA2) developed by Yezierski and Birk (2006). This instrument consists of 20 multiple choice items to assess students' conceptual understanding on particulate nature of matter. It includes 6 topics namely: size of particles, mass of particles, phases and phase changes, composition of particles, and energy of particles. This instrument has high reliability with a Cronbach  $\alpha$  of 0.83.

Below is the interpretation of students' scores in the ParNoMA2 test:

Score	Verbal Interpretation (VI)
18-20	Outstanding (O)
13-17	Very Satisfactory (VS)
9-12	Satisfactory (S)
5-8	Fair (F)
1-3	Poor (P)

### 2.4 Procedure

Figure 1 shows the schematic diagram of the research procedure in this study.

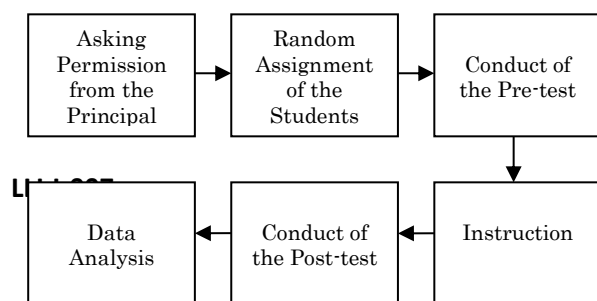


Figure 1: Research Procedure

### 2.5 Statistical Treatment

The data gathered were analyzed using Statistical Package for Social Science (SPSS) version 17.0. The following were the treatment made for the data:

**Frequency and Percentage:** Frequency was used to determine the distribution of students' level of performance in the pre-test and post-test while percentage was employed to determine the position of the students' level of performance out of the total number of students in each group.

**Arithmetic Mean:** The overall performance of the control and experimental groups was computed using the arithmetic mean. This was done by adding the scores of the students in a particular group and divided the sum by the total number of students that comprise in that group.

**Analysis of Covariance (ANCOVA):** This was used to determine the significant difference between the group using the traditional method and the group using POGIL in terms of their overall performance.

## 3. RESULTS AND DISCUSSION

### 3.1 Results

**Problem 1: What is the level of performance of the students in the control and experimental groups as measured in the pre-test and post-test results?**

Table 2 presents the level of performance of the students in the control and experimental groups. In the pre-test result, majority of the students have "Satisfactory" performance both in the control (57%) and experimental (55%) groups. Similar number of

students in both groups (control group = 3 or 14%; experimental group = 3 or 15%) is recorded to have “Very Satisfactory” performance. The remaining students have “Fair” performance.

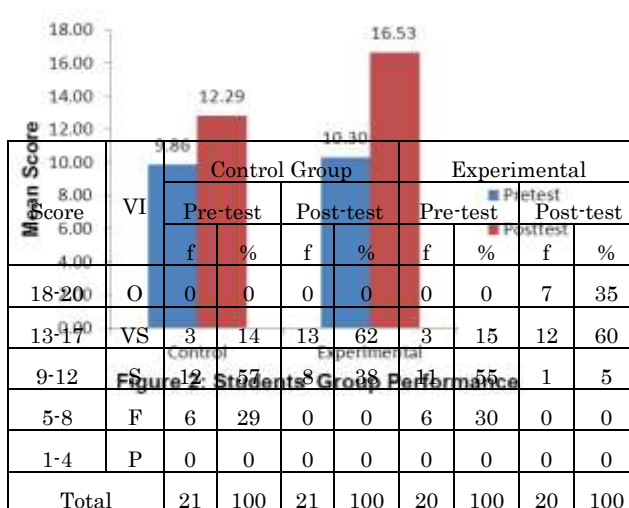
Table 2  
Students’ Level of Performance in the Pre-test and Post-test

In the post-test result, it can be observed that the performance of the students has increased as a result of instruction using both approaches. Students with “Very Satisfactory” performance in the control group have increased to 48%. This significant increase leads to a 19% decrease of students with “Satisfactory” performance. On the other hand, a 45% increase of students with “Very Satisfactory” performance can be noted in the experimental group. This is slightly lower than the control group because students with “Outstanding” performance in this group have increased to 35%. Along with this increase is the decrease of the number of students with “Satisfactory” performance which is 50%. No students in the control group achieved “Outstanding” performance. Furthermore, no students in both groups achieved “Poor” and “Fair” performances. This finding suggests that students who are exposed to POGIL method have better learning outcomes.

**Problem 2: Is there a significant difference between students’ exposed to traditional method of instruction and students’ exposed to guided inquiry instruction (POGIL) in terms of their academic performance in particulate nature of matter as measured in the post-test?**

Figure 2 shows the overall performance of the control and experimental groups before (pre-test) and after instruction (post-test). As reflected in the figure, there is very little difference on students’ mean score in both groups (group mean difference = 0.44) in the pre-test. This accounts for the homogeneity of the two groups. In fact Levene’s test of equality indicates that the relationship between the covariate (pre-test) and the dependent variable (students’ performance) did not differ significantly as a function of the independent variable (teaching method),  $F(1,39)=0.700$ ,  $p>0.05$ . However, overall mean score of the students in the experimental group

( $M=16.53$ ,  $SE=0.393$ ) is significantly higher compared to the mean score of control group ( $M=12.29$ ,  $0.384$ ) in the post-test.



In fact result of the test between-subjects effects using Analysis of Covariance (ANCOVA) ( $\alpha=0.05$ ) reveals that there is a significant effect of the between-subjects factor group,  $F(1,38)=43.02$ ,  $p<0.05$ ,  $\eta^2=0.53$ . This suggests that the use of POGIL instruction is significantly better in enhancing students’ academic performance compared with the traditional method. Furthermore, fifty three percent (53%) of this difference can be attributed to the POGIL instruction ( $\eta^2=0.53$ ).

### 3.2 Discussion



Results of this study showed that POGIL is an effective approach in enhancing students' academic performance over traditional method of teaching. This maybe because exposure to this method allows students to use higher order thinking skills. According to Dunkin (2009), students who are exposed to higher order thinking exercises achieve higher results in achievement test both in problem solving and comprehension. In the traditional approach, higher order thinking skills are usually not required as memorization of facts is common (Triangle Coalition for Science and Technology Education, 1993). Furthermore, Barthlow (2011) asserted that the POGIL method provides opportunities for in depth exploration of complex topics. Students have a platform for discussing their ideas and for testing their own mental models of sub-microscopic phenomena in chemistry as well as their understanding of symbolic representation. POGIL guides students to reconstruct their mental models into forms consistent with those held in the scientific community. As a result, students' academic performance could possibly be enhanced. This is very evident in this study.

The effectiveness of POGIL in enhancing students' academic performance in this study is in agreement with the results of previous studies. For example, Lewis and Lewis (2005) reported positive gains in students' achievement using this method. P. Brown (2010) and S. Brown (2010) also reported that students' test grades and overall test grades were positively affected by POGIL. S. Brown (2010) also stressed that POGIL improved grades in the course, encouraged active engagement with the material in the class, provided immediate feedback to the instructor concerning student deficits and misunderstandings, and created a positive classroom environment where students enjoyed learning very difficult material. These characteristics (POGIL characteristics) may have contributed to the success in enhancing students' academic performance in this study.

#### 4. CONCLUSION

Result of this study shows that POGIL method is better in enhancing students' academic performance. It also shows that students are more likely to learn when they are in a cooperative work

environment and when they are presented with models. These two characteristics are evident in the POGIL method.

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