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Research Article

Process Oriented Guided Inquiry Learning on Students' Achievement in Biology

Noronihar Datu-Dacula[a], Asgar Anda[b]

[a] Integrated Laboratory School – Mindanao State University, Philippines, noroniharabd@gmail.com
[b]Institute of Science Education – Mindanao State University, Philippines, asgar.anda@yahoo.com

Abstract

The purpose of this study was to investigate how Process Oriented Guided Inquiry Learning (POGIL) affected students' biology achievement at Mindanao State University-Integrated Laboratory School (MSU-ILS). The study used quasi-experiment with pre-test and post-test control group designs. The participants were the grade 8 Biology students who were grouped into two groups, control and experimental. The experimental group consisted of 41 participants who obtained teaching biology under the POGIL, while the control group consisted of 41 students who obtained teaching biology under Traditional Learning Based Approach (TLBA). The instrument used to collect the data in the form of test scores is the achievement test. Findings showed that before the intervention, there was no significant difference on the control and experimental groups of students' achievement test mean score but after the intervention, there was significant difference on the control and experimental groups of students' achievement test mean score. Similarly, there was significant difference on the control and experimental groups of students' achievement test mean gain score. It can be concluded that the POGIL in teaching Biology improved the achievement of the students compared to the TLBA. It is recommended that Biology teachers can use this approach in teaching the students to understand Biology well and improve their academic performance.

Keywords: Process Oriented Guided Inquiry Learning, Traditional Learning Based Approach, Achievement

1. Introduction

Learners are distinct in a myriad of ways. Students in a typical classroom will have varying experiences and, as a result, varying prior knowledge. Teachers endeavour to adapt the written curriculum into a format that can be used in the classroom and select what, how, and why students should study. Students differ on how they go about certain tasks related to learning, on how to think, and as to how they approach a problem (Bransford, 2000). These individual differences greatly affect students' performance in every learning task. Thus, teachers need to explore different strategies that can be applied to the different learning style of the students.

Process Oriented Guided Inquiry Learning (POGIL) is an active instructional method that is more appealing in the field of science and meeting the needs of new workplace. POGIL is currently adopted by many other disciplines to replace traditional lectures in the classroom (Farrell et al., 1999). A methodology on how students learn best, POGIL emphasises not only content mastery of a discipline, but also key process skills. The relationship between the two primary components of POGI, such as PO (process oriented) and GI (guided inquiry), is explained in this study. The PO component is derived from the frequent use of small groups with defined roles. Some evidence suggests that cooperative learning fosters positive attitudes toward the subject matter as well as the development of process skills such as critical thinking, teamwork, and metacognition. Perhaps the positive interdependence fostered in a group setting reduces the feelings of isolation, disorientation, and competition that are frequently associated with underachievement or failure in a traditional classroom setting (Hanson, 2006). Assigning students to teams by adopting POGIL-specific team role encourage positive

interdependence of the team. Each of these roles is critical to the team's success, so it is important to give students clear definitions (Vanags et al., 2013).

Moreover, Farrell et al. (1999) described the student's roles inside the groups, as well as the class processes. The roles of the students are Manager (in charge of ensuring that all activities are performed), Recorder (records the findings of the group), Presenter (presents the class with the group's responses), and the strategy analyst or Reflector (observes and makes observations about group dynamics). The role rotates; hence each member of the group is dependent with each other. A research at a large urban university looked at the impact of substituting one of three general chemistry courses each week with a POGIL-based peer-led team learning session (Lewis and Lewis, 2005). They discovered that students who participated in group learning sessions scored higher on common exams. On the other hand, the GI component involves the utilization of a well-organized learning cycle, which includes exercises that lead students to create their own understanding. Students' confidence has been demonstrated to develop as a result of such discovery experiences, as well as their ability to grasp and recall more. As a result, this study shows that applying POGIL approach in the classroom leads to improved knowledge and performance when compared to Traditional Learning Based Approach.

Furthermore, the facilitator's function differs from that of the teacher in a traditional classroom setting, where they present students with definitive knowledge and answers to their queries. In POGIL, rather than offering answers, the facilitator's role is to assist students in their knowledge creation. If the facilitator offers answers on a frequent basis, students become passive users of information rather than active creators of knowledge. Student-created discoveries are more remembered and retained. Actively engaging the students to the learning process will motivate them in constructing knowledge and developing critical thinking that will fill up the gaps in their mental representations.

Moreover, in POGIL sessions, the facilitator actively listens to group discussions and decides whether or not to intervene with guiding questions. Therefore the students must actively work to build new knowledge upon prior knowledge (Luxford et al., 2011). This is also supported by Straumanis (2010) who said that students learn best when they are given an opportunity to construct their own understanding based on the concept. He also added that learning is a fundamentally social act.

Furthermore, it is stated in the K-12 science curriculum that subjects are taught in a spiral progression from the most basic to the most complex concepts across grade levels. Students begin learning about biology, geometry, earth science, chemistry, and algebra as early as elementary level. After each level, this ensures mastery of knowledge and skills (DepEd, 2013). Thus, implementing POGIL in the classroom can support the K-12 education program.

The low performance of Filipino students in national and international assessments tests reflects the country's poor level of science education. In the latest Trends International Mathematics and Science Study (TIMSS), out of 40 countries, Philippines placed third to the last (Lopez, 2017). Recently, the Department of Education (DepEd.) data indicated a decline in the overall NAT (National Achievement Test) average for Grade 6 (40%) and Grade 10 (44.1%) students during the school year 2016-2017. These yield the conclusions that Filipino student’s factual knowledge on the science concept and reasoning are poor that turns out to low performance. Thus, teachers are very helpful in solving the problem as they are the front liners and play vital role in achieving quality education.

This alarming poor performance of the students provided a very good reason to utilize the process-oriented guided inquiry learning approach as an intervention in order to give the students the chance to become active participants in the learning process. The process-oriented guided inquiry techniques will give the students more opportunities to enhance their understanding on the science concepts thru POGIL activities and process skills. Thus, adopting the process-oriented guided inquiry learning approach to develop lessons in Grade 8 Biology can improve their performance in science. And by using POGIL in science classroom, it can give an idea to the teachers on how to use this process in teaching biology and can further develop their competence and methods of teaching.

Research Questions

Generally, the aim of the study was to investigate the Process Oriented Guided Inquiry Learning (POGIL) on the students’ achievement in biology. Specifically, it sought answers to the following questions:

(i) What are the control and experimental groups of students’ achievement level before and after intervention?

(ii) Is there a significant difference between the control and experimental groups of students’ achievement test mean scores in Biology before and after the intervention?

(iii) Is there a significant difference between the control and experimental groups of students' achievement test mean gain scores in Biology?

The following are the null hypotheses of the study tested at α=0.05 level of significance:

HO1: There is no significant difference between the control and experimental groups of students' achievement test mean scores in Biology before and after the intervention.

HO2: There is no significant difference between the control and experimental groups of students' achievement test mean gain scores in Biology.

Conceptual Framework

The study involved the investigation of the effects of the independent variable on the dependent variables. The independent variables are the POGIL and TLBA. The dependent variable is the achievement. In this study, the students were given a pre-test on achievement test before the intervention begins and post-test after the intervention. The flow of how the independent variables affect the dependent variables is shown in the research paradigm in Figure 1.

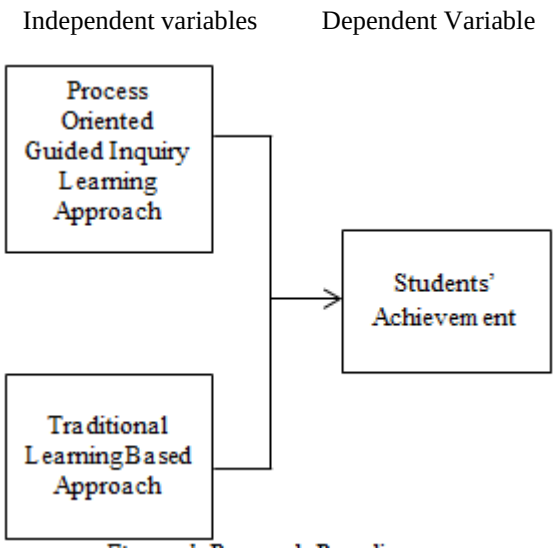

Figure 1. Research Paradigm

2. Methods

2.1 Research Design

Pre-test and post-test control group design was used in this study. The design is shown in table

Table 1. Research Design

Experimental	M	O	X	O
Control	M	O	C	O

Students in the experimental group were taught using Process Oriented Guided Inquiry Learning (POGIL), whereas students in the control group were taught using Traditional Learning Based Approach (TLBA). The symbol M refers to the matching of samples in the control and experimental groups of students on their grade. The symbol O refers to the observations. The first column of O's refers to the first observation made through administration of pre-tests. The symbol X refers to the instructional intervention in the form of POGIL given to the experimental group. The symbol C refers to the control or comparison group. The Second column of O's refers to the second observation made through administration of post-tests.

2.2 Subject Participant

This study was conducted at Mindanao State University Integrated Laboratory School (MSU-ILS) of the school year 2018-2019. The subject participants of this study were the two (2) intact classes of Grade 8 students of MSU-ILS. Both classes were grouped homogeneously based on their first grading grade in Biology.

2.3 Instrumentation

This study used POGIL activities in teaching biology. A POGIL lesson is a student-centred teaching approach that consists of brief introduction of the lesson which lasts 5-10 minutes. After the introduction, the students were grouped not more than four members. Each student was assigned a role. The roles are defined by Hanson (2005) and Barthlow (2011) as the manager, spokesperson, recorder, strategy analyst or reflector. The data were obtained through the achievement test adopted from the study of Sunggod (2012); Berdejo and Talib (2014). The reliability coefficient of the test used is the Kuder-Richardson formula 20 (KR20) since this does not require the assumption that all items had equal difficulty and the achievement test resulted to 0.77 value of Cronbach's Alpha, which signifies that the constructed test contained very good item. Moreover, the students' achievement levels were measured using the raw scores obtained in the achievement test. The level of achievement was adapted from Tawantawan (2017). The score obtained was transmuted based on the transmutation table of MSU-High School Units. The scores were classified as well-developed, developed, and less-developed.

3. Results and Discussion

Table 2 illustrates the numbers and percentage distribution of Grade 8 students' achievement levels before and after the intervention in the control and experimental groups.

Table 2. Numbers and Percentage Distribution of Grade 8 Students' Levels of Achievement in the Control and Experimental Groups Before and After the Intervention

Level of Achievement	Number (%) of Students before Intervention		Number (%) of Students after Intervention	
	Control Group	Experimental Group	Control Group	Experimental Group
Well-developed	0 (0%)	0 (0%)	6 (14.63%)	39 (95.12%)
Developed	12 (29.27%)	11 (26.83%)	35 (85.37%)	2 (4.88%)
Less-Developed	29 (70.73%)	30 (73.17%)	0 (0%)	0 (0%)
Total	41 (100%)	41 (100%)	41 (100%)	41 (100%)

Note: Raw Score: 43-56 – Well developed; 28-42 – developed; 0-27 – Less-developed

As shown in Table 2, before the intervention, almost all the students in both control (70.73%) and experimental (73.17%) groups were in less-developed level of their achievement. More than one-fourth demonstrated developed level of achievement in the control (29.27%) and experimental (26.83%) groups. None of the students demonstrated well-developed level of achievement in both control and experimental groups. Apparently, these results suggest that most of the students had no prior knowledge on the topics discussed to them. After the intervention, most (85.37%) of the students in the control group while so few (4.88%) of the experimental group demonstrated developed level of achievement. However, most (95.12%) of the students in the experimental group while very few (14.63%) in the control group demonstrated a well-developed level of achievement. None (0%) of the students in both control and experimental groups demonstrated a less-developed level of achievement.

Furthermore, as reflected in the result of the post-test after the intervention, many of the students both from control and experimental groups improved their levels of achievement. However, the experimental group showed higher level of achievement compared to the control group.

Table 3. Comparison between the two Groups of Grade 8 Students' Achievement Test Mean Score Before and After the Intervention

Period	Group	Mean Score	SD	t-value	p-value
Before Intervention	Control	25.41	3.354	-0.129	0.897(ns)
	Experimental	25.51	3.479		
After Intervention	Control	36.83	4.888	-8.846	0.000(s)
	Experimental	46.20	4.697		

Note: s – significant at 0.05 level; ns – not significant at 0.05 level

As shown in Table 3, before the intervention, both control and experimental groups of students posted a lower mean score (25.41 vs. 25.51) and very close with each other hence not significant ($p=0.897 > 0.05$). This suggests that the two groups of students were initially comparable in their achievement test. After the

intervention, the experimental group posted higher mean score than the control group (36.83 vs. 46.20) and is significant (p=0.000<0.05) in favour of the experimental group. Apparently, the instructional intervention given to the experimental group was found to be beneficial in raising students' achievement.

Table 4. Comparison between the two Groups of Grade 8 Students' Achievement Test Mean Gain Score

Group	Mean Gain Score	SD	t-value	p-value
Control	11.41	4.712	-9.525	0.000(s)
Experimental	20.68	4.077		

Note: s – significant at 0.05 level; ns – not significant at 0.05 level

In addition, as shown in Table 4, the mean gain score of the experimental group was also significantly higher (p=0.000<0.05) than the control group (11.41 vs. 20.68) with a t-value of 9.525 in favour of the experimental group. This study is supported by the researcher Villagonzalo (2014) showing that there were changes in the academic performance of students who were supported with POGIL approach as compared to those who were taught with traditional teaching approach. Moreover, the result of this study is consistent with the findings of the study of Coomarasamy (2016), Douglas & Chiu (2013), and Şen et al. (2016) that POGIL is an effective teaching method for enhancing student learning.

4. Conclusion and Recommendation

The influence of POGIL on the achievement of the groups was not significant before the intervention in which both control and experimental groups had mean scores that was very close with each other. However, the results of t-test after intervention showed that there was significant difference on the mean and the mean gain scores of Grade 8 Students' achievement test of control and experimental groups. From these results, we can recommend that biology teachers should use POGIL in their classroom since it is effective in teaching biology. It is also recommended that school and teachers implement more creative and imaginative POGIL approach in teaching science in order to understand science better so that motivation and interest of the students in learning science could be developed.

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Authors' Profile

NORONIHAR BALINDONG DATU-DACULA is an associate professor at Mindanao State University- Integrated Laboratory School, Marawi City where she taught Science subjects to high school students. She also taught sciences before in the secondary level in MSU-Taraka Community High School for 2 years. She finished her B.S. degree in Zoology from the College of Natural Sciences and Mathematics with units in education at the same university. In addition, she obtained her Master of Science in Teaching major in General Science at MSU-Naawan, Naawan Misamis Oriental.

Prof. Datu-Dacula is a scholar of the Department of Science and Technology- Science Education Institute (DOST-SEI), a member of the Philippine Society for Microbiology and the Philippine Association Foundation for Teachers Educators, Inc. (PAFTEI). She participated in several trainings and seminars both in local and national conferences. Currently, she is studying Doctor of Philosophy in Education major in Biology at MSU- Institute of Science Education.

ASGAR MACONDARA ANDA is a graduate of Bachelor of Science in Mathematics at Mindanao State University – Main Campus. He is also a graduate of Master of Science Education in Secondary Mathematics at the Same University under the Department of Science and Technology – Science Education Institute Scholarship. He was formerly a Secondary School Teacher at Department of Education, Bangsamoro Autonomous Regional in Muslim Mindanao, Philippines.