

The Efficacy of Process Oriented Guided Inquiry Learning (POGIL) in High School Biology.

Derek Chase, University Christian High School
Hickory, NC

Background

Process Oriented Guided Inquiry Learning (POGIL) is a teaching strategy that utilizes collaborative groups that learn through exploring, inventing, and applying concepts (POGIL, 2016). The concepts are presented through models that present information in figures, tables and or diagrams. Each model begins with directed questions that ask students specific questions from the model. Then the questions become more convergent and divergent requiring higher level thinking skills. Students construct their understanding of the content through this approach. There are specific roles for each group member that includes the following: the manager, reader, recorder, and presenter. These roles give participants structure and responsibilities within their collaborative groups. This guides their understanding of concepts, critical thinking skills, application of information, and communication in science (Bailey, Minderhout, & Loertscher, 2011). POGIL has been implemented in a variety of science courses including: chemistry, physical science, biochemistry, biomechanics, microbiology, anatomy and physiology, nursing, engineering, information technology and introductory STEM classes.

Since research in the area of POGIL in the high school biology classroom was limited, I chose to test this inquiry teaching method in my classroom. This capstone project was designed to investigate the efficacy of POGIL in the high school biology classroom. Specifically, I wanted to see if using POGIL increased student achievement, engagement in and positive attitudes towards biology.



Figure 1. Collaboration.



Figure 2. Concept Invention.

Table 1
Data Triangulation Matrix

Research Questions	Data Source 1	Data Source 2	Data Source 3
Did student test scores improve in biology?	Unit Pre-Tests	Unit Post-Tests	Quizzes
Did student engagement increase in biology?	Post Treatment Questionnaire	Student Interviews	Observations/ Journal
Was there a positive attitude towards learning biology?	Post Treatment Questionnaire	Student Interviews	Observations/ Journal

Methodology

The study population included 9th-11th grade biology students at University Christian High School in Hickory, NC. There were two sections of biology with 15 in one class period and 8 students in the other period.

One class period was the treatment group and was taught two units using the POGIL strategy using selected activities from the POGIL Activities for High School Biology book. The other class period was the comparison group and was taught the same two units without the POGIL strategy but through traditional lecture and notes. The treatment and comparison groups were switched after two units to reduce the effect of class composition on the results.

Students in each group took pre-, post-tests, and quizzes for each of the four units. The pre- and post-test data was analyzed for normalized gains in both groups. Normalized gains were compared between the treatment and non-treatment groups. The post-test scores were analyzed using the Permutation Test to test for significance in the difference between groups.

Each group took a quiz per unit and a Post Treatment Questionnaire to determine their engagement and perception of the teaching method received. Moreover, eight students were interviewed to be interviewed using the Post Treatment Interview Questions. The research questions and data collection instruments used to answer those questions are summarized in Table 1.

Results

According to Hake (1998), *high* normalized gain scores are greater or equal to .7, *medium* scores are between greater or equal to .3 but less than .7, and *low* scores are less than .3. The non-treatment group achieved medium normalized gain scores where as the treatment group achieved high normalized gain scores. The unit pre and post test data is summarized in Table 2. The quiz data is summarized in Table 3. There was a statistical significant difference in the scores for three of the four unit tests and three of the four quizzes between the two groups.

Table 2
Unit Pre and Post Test Data Summary

Unit Test	Non-Treatment Group Normalized Gains Mean	Treatment Group Normalized Gains Mean	P-Value	Significant
Cell Structure, Function & Transport	.55	.79	0.0001671	Yes
Bioenergetics	.59	.77	0.006843	Yes
Reproduction, Growth & Development	.63	.70	0.4022	No
Ecology	.49	.76	0.00146	Yes

Table 3
Quiz Data Summary

Quiz	Non-Treatment Group Mean	Treatment Group Mean	P-Value	Significant
Cell Structure & Function	79%	89%	0.02754	Yes
ATP & Photosynthesis	77%	86%	0.1189	No
Cell Size & Cycle	73%	85%	0.03496	Yes
Energy Flow & Nutrient Cycles	75%	87%	0.009518	Yes

Conclusions

Since the p-value was less than the alpha value for both the difference in normalized gains and the post tests between the two groups for three of the unit tests, the null hypothesis was rejected. In addition to the unit tests, the p-value was less than the alpha value for the difference in quizzes between the two groups for three of the quizzes. Again, the null hypothesis was rejected. The null hypothesis being that there was no treatment effect.

The statistical tests suggest that the POGIL teaching strategy was more effective than the traditional teacher centered lecture delivery for the units in cell structure, function and transport, bioenergetics and ecology.

References

- Bailey, C. P., Minderhout, V., and Loertscher, J. (2011). Learning transferable skills in large lecture halls: implementing a POGIL approach in biochemistry. *Biochemistry and Molecular Biology Education*. 40 (1), 1-7.
- Hake, R. R. (1998). Interactive-engagement versus traditional methods: A six-thousand-student survey of mechanics' test data for introductory physics *American Journal of Physics*, 66(1), 64-74.
- Kayser, T. (2016). True collaboration is a partnership: six ingredients for making it so. [Digital Image]. Retrieved from <https://www.linkedin.com/pulse/20140418191855-78767208-true-collaboration-is-a-partnership-six-ingredients-for-making-it-so> November 24, 2016.
- POGIL. Process Oriented Guided Inquiry Learning. (2016). Retrieved from <https://pogil.org> November 24, 2016.

Contact

Derek Chase
University Christian High School
Email: dchase@uchigh.com
Website: <http://uchigh.com>
Phone: 828-855-2995

