

Analysis of the Traditional Method of Teaching and POGIL Employed in a One Semester Engineering Materials Technology Course

Dr. Nibert Saltibus, Sam Houston State University

Assistant Professor Department of Agricultural Sciences and Engineering Technology Sam Houston State University Email:nes021@shsu.edu Tel:9362941201

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Abstract

A review of the literature has shown the interest and implementation of the Process Oriented Guided Inquiry Learning (POGIL) method in introductory Materials Science and Materials Engineering Courses. In this limited study, in an Engineering Materials Technology course, both the Traditional method of teaching and POGIL were employed. At approximately one third of the semester, students were assessed solely on the Traditional method of lecturing, at approximately the second third of the semester, students were assessed after both methods were employed, and at the end of the semester, the students were assessed only on the use of POGIL. The first assessment, which was based on the Traditional method, will be used as a bench mark. Concerning resources for this class, two materials textbooks were utilized for this purpose, a Materials Science and Engineering, and a guided inquiry Materials Science and Engineering textbook, each by different authors. The feedback of the students was also received in the form of a survey given them by the instructor, and will be further analyzed, in an effort to indicate information, such as their preference of the Traditional method of teaching versus POGIL, and the particular learning method that they believe to have had a greater impact on their learning. Students also indicated whether group members did contribute effectively to their learning outcomes, as they also worked in groups during the implementation of POGIL. Although other forms of evaluation were utilized during the specific semester, such as report writing and power-point presentations, these were not included in the study, as they may not have had a direct bearing on the research.

Introduction

Process Oriented Guided Inquiry Learning (POGIL), as noted by Douglas and Chiu (2012), was originally developed for curriculum in Chemistry, but presently has had a wider scope in fields, such as Biology and Engineering. Douglas and Chiu employed POGIL over separate semesters over control and treatment groups in an Introduction to Materials Engineering Course. Final course grades were utilized for the measure of effectiveness. Their findings revealed no significant difference in grades between the control group and the treatment group ($p < .05$), where, on the other hand, significant difference in course grades between the control group and the second treatment group ($p < .05$) was observed. Moreover, Yang (2013) utilized POGIL, supplemented by Active Learning Activities in a hybrid approach in a Materials Science Course. Yang (2013) measured quantitative learning with pre and post test results from the Materials Concept Inventory (MCI). The students were placed in groups and were assigned various roles such as manager, time keeper, etc. (Yang, 2013). Furthermore, Yang (2013) also presented the students with a survey at the end of the semester to assess their preference based on three groups. Most of the students thought that Type 3 (Hybrid) was most effective for learning. Recently, Kim and Faseyitan (2014), employed POGIL into a Green Plastics Laboratory Course, focusing on fundamentals of polymers testing. The skills and knowledge required in engineering tasks, which includes teamwork and problem solving, for manufacturing products are also reflected in

this laboratory course (Kim and Faseyitan, 2014). As part of the authors' conclusions, Kim and Faseyitan (2014) noted that the POGIL lab environment implemented by the new approaches, reflected positive responses from the survey results; notwithstanding there was disagreement among student responses.

In the field of Chemistry, students that previously were enrolled in General Chemistry in a POGIL environment, and went on to Organic Chemistry, were assessed (Farrell et al. 1999). Generally, there was an increase in percentages from grades A to C, and approximately half of the percentage decreased in those receiving grades from a combination of D and F, including W grades (Farrell et al., 1999; Johnson et al., 1991). It was also noted that the students scored as high or even higher than past students taught within a Traditional course environment by the same instructors.

Moreover, the author learned about POGIL through a department colleague from another professor in a different college department, who wanted to know the faculty that were interested in teaching methods (POGIL) and the author showed an interest in its implementation. The author revised some of the literature on POGIL, and after receiving permission from the students, implemented POGIL. It was implemented generally after Exam 1 and an additional Traditional lecture on a chapter was issued to the class, in an effort to possibly have an improvement overall from Exam 1 assessment results (second and third assessments).

Learning Methods and Analysis

In the Spring of 2016, both the Traditional method of teaching and POGIL were employed in an Engineering Materials Technology Course. At approximately one third of the semester, students were assessed based on the class average of Exam 1 after only the Traditional method of teaching was employed, where this was taken as the benchmark. Before POGIL was implemented, the students were made aware of the purpose and given a brief background (Yang, 2013). Although in the groups, based on the literature, various functions were assigned such as manager, recorder, etc. (pogil.org; Farrell et al., 1999; Yang, 2013), only the roles of leader/manager and time keeper was assigned to the groups. The minimum number per group, which was four students, possibly may have decreased during the semester. The students were then assessed from the average of Exam 2 after both methods were employed (Traditional and POGIL methods). The final exam (Exam 3) was based solely on POGIL; that is, all students were fully assessed based on chapters that were covered with the POGIL experience. Two textbooks were utilized throughout the semester, (Callister and Rethwisch, 2014) and the POGIL materials textbook (Douglas, 2014).

Projects and other assignments, including homework, were given to students, but these were not utilized in this research in the assessment of POGIL. Using the average of Exam 1 as a benchmark, there was no percentage change in Exam 2 average. However, there was a 14% increase in the class average of Exam 3 in comparison to the benchmark average (Exam 1). It must be noted that the average percentage for each assessment were rounded to the nearest whole number. The class sample for Exam 1 and Exam 3 analyses was 20 each. Although 21 students took Exam 1, one student did not continue to pursue the course, and this student score was not included in the benchmark average. Additionally, the number for Exam 2 was 19 (one student

had to be accommodated) and, therefore, the exam result was not included with the balance of the class. Limited assistance was given to groups; sometimes the answers would be provided to reassure students that they were on the right path. Toward the end of the semester students were given surveys to help in an effort to identify information, such as the learning method they believed to have had a greater bearing on their learning. The questions issued are found in Table 1 and quantitated in Figure 1. Based on Question 1, 58 % responded that the Traditional method of teaching was preferred, as compared to the 42 % that chose POGIL. This shows that there is still a strong preference for the Traditional method, not dismissing the fact that POGIL response was below 50%, it still had a relatively fair favorability. Question number 2 seeks to understand which of the learning methods the student believed had a greater impact on their learning. The response, were almost the same for both methods, where 53% believed that the Traditional method had a greater impact. POGIL at 47 % again shows that this method, students believe, is helping their understanding of concepts related to the Engineering Materials course. It must be noted that one student did not answer any of these two questions (Question1, and Question 2) based on the responses that was issued in the survey, and therefore was not included in the evaluation. Furthermore, as students were placed in groups, they were asked whether their respective group members contributed effectively to the material. There was an overwhelming response in the affirmative (yes), 68 %, as opposed 32% which answered no. This suggests that in a POGIL environment, students' help each other succeed. Moreover, as noted earlier each group had a manager/leader and a time keeper. Based on Question 4, and the response from Figure 1, the responses was the same, 50 % responding yes, they believed they did, while 50% believed that these two roles were not beneficial to the group. Again, it must be noted that one student answered yes, but wrote *not sure* on the Questionnaire; still that student was included in the analysis.

Table 1 Survey Responses based on Questionnaire

1. Which learning method do you prefer?
(a) The traditional lecture method employed in approximately the first half of the semester
(b)The Process-Oriented Guided Inquiry Learning (POGIL) method implemented in approximately the second half of the semester.
2. Which learning method do you think had a greater impact on your learning?
(a)The traditional lecture method employed in approximately the first half of the semester.
(b)The Process-Oriented Guided Inquiry Learning (POGIL) method implemented in approximately the second half of the semester.
3. Did your group members contribute effectively to the learning of the material?
Yes
No
4. Do you believe that both the functions of the group manager and time keeper were beneficial to the group?
Yes
No

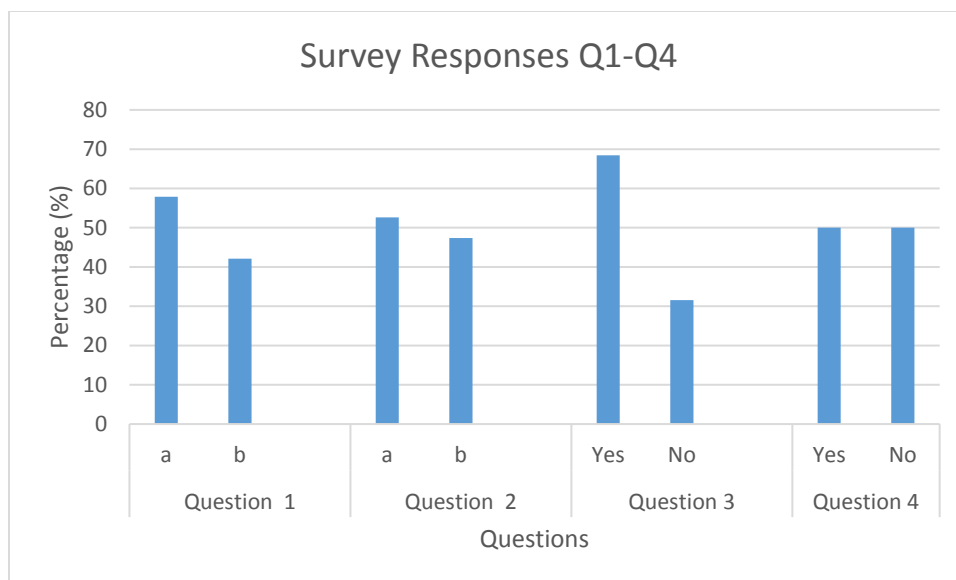


Figure 1: Response from Questionnaire (Questions 1-4)

For Question 5, students were to comment on the use of both learning methods implemented within the one semester and for Question 6, students were questioned concerning the advantages and disadvantages associated with the use of the Process-Oriented Guided Inquiry Learning (POGIL). Some of these responses are given in Table 2.

Table 2 Question 5 and 6 Responses from same Questionnaire for (Questions 1-4)

5. Comment on the use of both learning methods implemented within the one semester
-“The first half felt as if it was a review rather than teaching the material [.] The second half did not have enough material to explain the equations [.] I had to use the internet more than the given material.”
-“Neither were great but I would rather work independently because everyone works and learns at different paces”
-“I feel I learned better with the first method of learning, the second way was unorganized and students had to rely on others so much”
-“First method: A lot of information in short time, felt unorganized and hard to follow sometimes, POGIL: I thought this was effective and more enjoyable”
-“I believe the traditional method was better for me because each individual can learn from the professor more. The second method did not help me a lot, most of the time my group member get to[o] far ahead and did not explain it clearly to me or they did not feel like doing it”
-“I thought the first method was better than the second But I like the book we used the second half”
-“The material build off each other so, it was to our benefit to have the basics traditionally taught + the remainder self guided”
-“I prefer to be taught the material. Having the professor work through actual problems every day would be most beneficial.”

-“Sometimes the traditional lecture method was very boring and the students was not paying attention. On the other hand, the other methods made us get involved in the process and assignments”
-“POGIL is better in [a] sense student develops own understanding.”
6. What were the advantages and disadvantages associated with the use of Process-Oriented Guided Inquiry Learning (POGIL)?
Advantages
-“Learn at own pace”
-“Easy to ask questions”
-“More in depth study done by students”
-“Relaxed, able to ask more questions and receive more help than old method. Easier to understand from the new book more straightforward”
-“Its group work, should help to learn from each other”
-“The book was better and was slower so had more time to learn material.”
-“Easier to Study [/] Own notes”
-“Worked through material slowly.”
-“It was a good method of learning by ourselves”
-“Greater understanding of material”
Disadvantages
-“Did not have enough material to explain the equations”
-“Worked at different paces, taught myself instead of professor teaching”
-“more work load, felt like I taught my Self material with little to no help from others”
-“Groups only work when everyone is on same page, having 4 people is harder than groups of two.”
-“People tend to get to far ahead and don’t explain it to everybody, that one person that always gets left behind. It was a very ineffective method for me, probably cause me to fail the class.”
-“I had to basically learn material myself. I prefer to be taught, and then given practice problems.”
-“We practically teach ourselves, with little/no help from professor”
-“The group had struggled to teach each other material that was very difficult”
-“Not enough class time”
-“new book, couldn’t take book home, some group members may not contribute”

Concerning hurdles, one particular one that was noted is that students did felt that they were teaching themselves as is reflected in the survey responses. Moreover, students were assigned groups early into the semester to write a report/literature review (project) on various topics of interest in the field of Engineering Materials Tech. Much of the work and discussions would have taken place outside of class. As mentioned earlier, they were not included in the study.

Conclusions

Two learning methods were employed within one Spring 2016 semester, in an Engineering Materials Tech. course at Sam Houston State University, under the Department of Agricultural Sciences and Engineering Technology. The manner of instruction was the Traditional method of teaching approximately the first half of the semester, and the POGIL method at approximately the second half of the semester. When POGIL alone was employed in the final Exam 3 assessment, students performed better than when only the Traditional method was employed and also when the second assessment was based on both methods. Students generally preferred the Traditional teaching method though not by a large margin over POGIL. Moreover, 6 % more students believed that the Traditional lecture method employed in approximately the first half of the semester, had a greater impact on their learning, than POGIL, again a small margin. Based on this limited study, the author may in the future, rather than implementing both learning methods within one semester, implement a full POGIL study in one semester and a full Traditional lecture (which is the current practice in 2017), in another semester (Douglas and Chiu, 2012), as this maybe a best practice, although that may not necessarily be the case.

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