A POGIL EXERCISE TO TEACH DATABASE DESIGN

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ABSTRACT

A POGIL (Process Oriented Guided Inquiry Learning) exercise was created to teach database design to business students. The argument for using POGIL and the exercise are included. There was a 5% improvement in test scores in two classes (Introduction to Management Information Systems, and Systems Analysis and Design) that experienced the POGIL exercise compared to test scores from two similar classes that did not use POGIL. The differences were not statistically significant given the small class sizes. Students did express enthusiasm for the POGIL exercise.

INTRODUCTION

Process Oriented Guided Inquiry Learning (POGIL) was developed by the National Science Foundation in response to the perception that students were not learning adequately through use of traditional techniques like lecture [4]. The use of POGIL is most widespread in chemistry and biology, with books devoted to prepared POGIL exercises for various course topics [2] [5]. However, POGIL is also spreading slowly to other disciplines, including an exercise for a Marketing class [3], and some exercises for Computer Science topics [7]. The topic of database design is taught in both Computer Science and in Management Information Systems classes in Business, but an existing POGIL exercise for database design could not be found at the time of this research.

WHAT IS POGIL?

Key to the concept of POGIL is student-centeredness. Rather than the teacher-centered approach of presenting lecture material at a pace which may be too fast for students to absorb or so slow that students get bored, a POGIL exercise guides students working in teams through exploring a phenomenon, observing specific aspects of the phenomenon, and then presenting the students with the applicable principles and terminology. Students then apply the principles to further exercises.

Each student on a team of three or four is assigned to fulfill one or more of the standard POGIL roles – manager, reflector/technician, recorder, and presenter. The term "process oriented" in POGIL refers to the intention to allow, in addition to mastery of course content, improvement in learning techniques. As students fulfill the responsibilities of their assigned roles and work as a team to find answers about the content, their abilities with process-oriented skills such as problem solving, critical and analytical thinking, and oral and written communication are improved.

Studies have shown that the copious use of guidance, hints and pointers used throughout the heavily structured POGIL exercises ensures that students have access to sufficient knowledge to learn the new material [8] [6] [1]. It is also recognized that developing exercises which contain the careful sequencing of activities to provide this structure is a significant effort [3]. Hale and Mullen [3] also found that students were more engaged in their coursework and liked using POGIL. The mission statement at the author's campus includes these statements: "to offer opportunities for dynamic student engagement … Our campus values …innovation, experiential learning..." [9]. A POGIL workshop was offered on our

campus to increase instructor innovation and use of experiential learning techniques. This exercise was developed so that the author could determine just how much effort was involved to make use of this teaching innovation, whether students demonstrated improved mastery of the topic, and whether students were more engaged with the material and liked POGIL.

METHODOLOGY AND CONCLUSIONS

One of the intended outcomes of this research was to determine the effort required to create a POGIL exercise. The author attended a six-hour workshop on POGIL methods, and developed the POGIL exercise. The exercise took approximately eight hours to create, and was slightly improved by adding stopwatch timing of steps after conducting the exercise first in the Systems Analysis and Design class. It is likely that improved practice in exercise creation and increased knowledge about POGIL principles would improve both the process of creating exercises, and the quality of the exercises.

Another intended outcome was to determine whether students' mastery of the topic increased with the use of POGIL. The author teaches database design in three different classes. These include the lower-division Introduction to Management Information Systems (Intro to MIS) which is required of all business majors, the upper division Systems Analysis and Design (SA&D) which is an elective for business majors, and a required course for Masters of Business Administration (MBA) students on MIS topics. While the SA&D students had been introduced to database design in the prerequisite Intro to MIS course, the topic is difficult enough to be worth repeating several years later in the SA&D course. There was no expectation that the MBA students would have any familiarity with database design. In previous semesters, all three classes had included individual, non-POGIL exercises in class to illustrate the concepts of database design. During the fall 2014 semester, the POGIL exercise was conducted instead of the individual exercise in all three classes.

To evaluate whether mastery improved by using POGIL, scores for the two undergraduate classes (Intro to MIS and SA&D) on database design exam questions were compared to scores from the same classes (answering the same questions) in previous semesters when POGIL was not used. Objective exams were not used in the MBA course, so it was not possible to do a statistical test of learning improvements in the MBA course. Although there was a 5% improvement in scores in both of the undergraduate classes that had the POGIL exercise, the differences from the scores without POGIL were not statistically significant in either set of classes. The small class sizes, of 23 and 15 in the Intro to MIS classes, and 14 and 10 in the Systems Analysis and Design classes, contributed to the problem of finding a significant difference.

The third intended outcome from this study was to determine whether students were more engaged with the material and liked the POGIL exercise. For this outcome there is only anecdotal evidence. In previous experience with other in-class teamwork (which were not POGIL assignments) it was found in end-of-course written evaluation statements that students very much liked working together in class in teams. Likewise, students stated in class at the end of this POGIL exercise that they very much liked doing the POGIL exercise. Those who had read the chapter on database design before doing the POGIL exercise said that the POGIL exercise helped them understand the chapter. This anecdotal evidence suggests that POGIL exercises may be consistent with the intention of the campus to increase student engagement and provide experiential learning.

There was significant work involved in preparing the POGIL exercise, which suggests sharing prepared exercises in venues such as this conference, as well as in books and journals would be of value. There

was not statistical evidence of improved mastery, but further studies utilizing larger sample sizes may provide that evidence. Anecdotal evidence suggests that students are more engaged with the course topic when using the POGIL exercise, and thus, it would be worthwhile for the reader to try out the exercise included in the Appendix.

APPENDIX – THE POGIL EXERCISE

Teaching Instruction: Using the indicated page breaks, create a six page handout for students, but do not collate or staple the pages. Rather, give each group stacks of page 1, page 2, etc. Divide students into groups, and ensure that several groups have only 3 students. Assign POGIL roles to individual students loudly, stating for several groups that one student is both the Reflector and Presenter. Instruct groups to take Page 1, read and work individually for one to two minutes through the first Critical Thinking Question set only, and then take one to two minutes to discuss as a group. Monitor the time, and call out when the time is up. After groups have discussed, ask each presenter to give the team answers for each question. After all groups have presented, the instructor briefly clarifies any misconceptions. This process of working through information and question sets one at a time, then discussing in small groups, then confirming with the class before moving on to the next piece of information and/or question set is repeated to the end of the exercise. In this way, students are led step by step through a guided inquiry, reading new information only when they are ready for it. Instructors will judge whether one or two minutes of discussion is needed at each step. In most cases, only one minute was needed for both individual work and group discussion. With this timing, the exercise was completed in about 45 minutes in a class of 15 students. (Page break)

Title: Learn How to Design Tables for a Database

FIGURE 1. FIRST SET OF TABLES.

Table 1

Student Name	Class standing	Male/Female
Julie	3	F
Harris	3	M
Diane	4	F
Juan	3	M
Genvieve	4	F
Jose	4	M
Richard	3	M
Amy	3	F
Kim	4	F
Ng	4	M

Table 2

POGIL Group Number	# of students in group	Date group was formed
1	4	9/15/2014
2	3	9/15/2014
3	3	9/15/2014

Table 3

Role Name	Essential Role?	Role Description
Manager	Yes	Manages the group. Ensures that members are fulfilling their roles; the assigned tasks are being accomplished on time, and all members of the group are participating in the activities and understanding the concepts.
Recorder	Yes	Records the names and roles of the group members at the beginning of each activity. Records the important aspects of the group discusssions, observations, insights, etc.
Presenter	Yes	Presents oral reports for the class for the group.
Reflector	No	Observes and comments on the group dynamics and behavior with respect to the learning process. The reflector may be called upon to report to the group (or the entire class) about how well the group is operating (or what needs improvement) and why.

Critical Thinking Question Set 1: Pick a row, any one row, in Table One. What is the data in that one row describing? What is all the data in that table describing? (The answer will be very short.) Answer these questions for Table Two and Table Three also. (Page Break)

Information: Each main (or base) table in a database describes a person, place, thing, or concept. These persons, places, things, or concepts are called **entities**. Each row represents one entity, and the table as a whole represents an **entity class**.

Critical Thinking Question Set 2: What are the three ***entity classes*** represented by the tables? Name some of the individual ***entities*** being described in Table One.

Critical Thinking Question Set 3: In Table One, which column has values that are unique? In other words, the values in the cells are not repeated as you read down that column? Identify columns with unique values for Table Two and Table Three also. (Page Break)

Information: Columns that have unique values can function as **primary keys** for the tables. Generally columns with short, concise values are used for primary keys.

Critical Thinking Question Set 4: What are the best columns to use for primary keys for Tables 1, 2, and 3?

Critical Thinking Question Set 5: Choose one student from Table One. Given what you know about the POGIL groups in this class, is that student entity going to be associated with one POGIL group (in Table 2), or more than one POGIL group?

Identify one POGIL group in Table Two. Is that POGIL group going to be associated with one student, or more than one student?

Are there any students that are associated with more than one role? (You can answer this by looking at the people holding roles in your group and other groups.)

Thinking about all the groups in the room, is a particular role (like Manager) held by only one student in the class or more than one of the students in the class? (Page Break)

Information: Relationships between entities can be described by the number of entities that can participate in the relationship. Either:

- only one entity from a table can participate in the relationship, or
- more than one entity from a table (many entities) can participate in a relationship.

For instance, a Professor can teach a section of **many** classes, like a section of MIS 250 and a section of MgtOp 340. But a class section is taught by **only one** professor. So we say that there is a One – to – Many relationship between a Professor and a Class section. One professor can teach many sections of classes, but a section of a class is taught by only one professor.

A Student can register for **many** Classes. A Class is registered for by **many** Students. In this case, we have a Many – to – Many relationship between Classes and Students. A student can register for **many** classes, and a class can be registered for by **many** students.

Critical Thinking Question Set 6: What is the relationship for the following entities, One – to – Many, or Many – to – Many?

Groups to Students:

Students to Roles: (Page Break)

Critical Thinking Question Set 7: Compare Table 1 and Table 4 -- what has been added to Table 1 to form Table 4?

FIGURE 2. SECOND SET OF TABLES.

Table 4

Student Name	Class standing	Male/Female	POGIL Group Number
Julie	3	F	1
Harris	3	M	3
Diane	4	F	2
Juan	3	M	1
Genvieve	4	F	2
Jose	4	M	3
Richard	3	M	1
Amy	3	F	1
Kim	4	F	3
Ng	4	M	2

Table 5

Role Name	Student Name
Manager	Julie
Manager	Harris
Manager	Diane
Recorder	Juan
Recorder	Genvieve
Recorder	Jose
Presenter	Richard
Reflector	Amy
Presenter	Kim
Presenter	Ng

Critical Thinking Question Set 8: What is the function of POGIL Group Number in its original table (Table 2)? (Hint: check the answer to Critical Thinking Question 4). Study Table 5 – what are the functions of the two columns in Table 5 in their original tables (Table 1 and Table 3)?

Critical Thinking Question Set 9: Can you tell, from looking at Tables 1, 2 or 3, which student is in which group, or which student has which role? What table allows you to find the group a student is associated with? What table allows you to find the role(s) a student is associated with? (Page Break)

Information: We know that one Group will be associated with many Students. So Table 2 and Table 1 have a one-to-many relationship. To represent a one-to-many relationship:

- the primary key from the one-side of the one-to-many relationship…
- …is added to the table on the many-side of the relationship.

The primary key from Table 2 is POGIL Group Number, so POGIL Group Number is added to Table 1.

We know that a Student can be associated with many Roles, and a Role will be associated with many students. So Table 1 and Table 3 have a many-to-many relationship. To represent a many-to-many relationship between entities

- the ***primary keys*** of both entities are put into a new table.
- This new table is called an ***associative entity*** – this new table allows the database software to associate the two original tables. The original tables are called **base tables.**

Critical Thinking Question Set 10: Looking at just the data in Table 5 alone, can you figure out the class standing of the Manager of POGIL Group 1? Looking at just the data in Table 4 alone, can you figure out the class standing of the Manager of POGIL Group 1? Looking at the data in Table 4 and Table 5 together, can you figure out the class standing of the Manager of POGIL Group 1? What table is an Associative Entity?

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