



Article

Is process-oriented guided-inquiry learning (POGIL) suitable as a teaching method in Thailand's higher education?

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Abstract

An overview of recent literature on the suitability and sustainability of the teacher centered classroom instruction mode reveals that this model is no longer adequate in meeting the educational goals and needs of students that are destined to function as professionals in an increasingly complex and interdependent world system. Many alternative models have been proposed, some of these seek to reform either curriculum and/or course content, others rely heavily on technology, and yet a third seeks to involve students in accepting responsibility for their learning. POGIL (*Process-oriented guided-inquiry learning*) belongs to the latter. In a POGIL classroom, students work in groups (called learning teams) on assignments with the goal of mastery of content. The assigned tasks seek to develop work place valued skills such as higher level thinking and metacognition, communication, teamwork, management, and assessment. In this environment, the student is weaned from relying on memorization and develops the skills needed for success in course work, college, and career. The instructor assumes the role of coach rather than expert authority. A discussion of the POGIL classroom dynamics and a hands-on demonstration will be provided to determine if this philosophy and strategy is suited for the Asian classroom.

Keywords: process-oriented, guided-inquiry, learning, metacognition

Introduction

I want to express my warmest and sincerest appreciation and thanks to Dr. Dan Apple, founder and president of Pacific Crest, as an inspired motivator and “guru” of process-education. He gave me the permission extensively to make use of the *Instructor’s Guide to Process-Oriented Guided-Inquiry Learning* by David M. Hanson. I also thank David Hanson [1] and the other POGIL project personnel Diane Bruce, Frank Creegan, Richard Moog, Linda Padwa, James Spencer, Andrei Straumanis, Troy Wolfskill, Joe March [2], Ken Caswell, Jennifer Lewis, and others for their inspired work that compels many of us to examine ourselves if indeed we are facilitating learning and if we are preparing new generations for their particular and peculiar challenges. Christine Brooms of Prairie State College was the first to introduce me to POGIL: I thank her for getting me hooked. Anna Helwig of South Suburban College encouraged me to use the philosophy.

I used the process-oriented guided-inquiry learning (POGIL) philosophy and strategy for teaching and learning in 2007-8. During the fall semester I implemented weekly POGIL activities in three general chemistry courses and in 2008 also used them in the chemistry portion of a physical science course. This does not make me an expert in POGIL but my training in cooperative learning groups for English as a Second Language (ESL) allowed me to recognize its tremendous value. Half way through the semester I was rewarded: A recognizable change in attitude toward the course took place in students who for the most part came to the first lesson poorly motivated. The final outcomes did clearly delineate the benefit of using POGIL, but what did transpire in their appreciation toward their ability to understand science has made me an advocate for POGIL: “Dr. Z, I am going to take the second general chemistry course.”

The purpose of this article is informative and its intention is to awaken in the reader the desire to explore POGIL for the benefit of her/his students and thus become a “knowledge-mentor.” Since I only have anecdotal data to share, I extensively have relied on the testimony and analysis of the above named experts in conveying the benefits of POGIL and have “borrowed” extensively from their excellent work [1].

The Science Education Process

It is generally recognized that the science education process has two components, content and process. Content deals with the structure of knowledge while process is the skills needed for acquiring, applying and generating knowledge [3]. Traditionally in science, schools and colleges, the attention has been on the content, leaving the process emphasis for higher-level training. The rationale has been: “Students need to get the facts before they can apply them.” This often makes science dry and a necessary evil needing a passing grade [4, 5, 6, 7]. The excitement for systematically discovering the natural world a 5th grader experiences has vanished by the time he/she arrives in college. Turned away from science, now it is time for the required general science education courses and here students are having problems. In general, academic language is abstract and commonly has no context clues for understanding. In particular, science has its own language and learning its jargon is in itself a challenge: Armed with a half way understood concept and few context clues, is it a wonder that the student has difficulty with science [1]? Even laboratory assignments rarely are cognitively demanding and

very often context reduced. Under these conditions, students follow instructions cookbook-style without giving a thought of what was learned or how it could be applied. The result is general apathy and frustration toward science, leading to dropping the course or just tolerating it [5]. Students are short changed!

At the end of the educational process await more challenges: As the problems become more and more global, interdisciplinary, complex and complicated, society demands technological breakthroughs in shorter and shorter time slots. To keep up with the pace, the professional needs successfully to develop highly diversified idea-processing skills. Are we science teachers teaching our students to succeed under these circumstances?

Recent surveys of industrial employers show that science education needs to provide the student with the skills of information processing, critical and analytical thinking, problem solving, communication, teamwork, management and assessment required by today's globally competitive world. The demands of an increasingly mobile professional world require of students to be prepared to survive not only academically but primarily in their future careers in a very dynamic environment. They need to be quick learners that rapidly discard "dud" resources, solutions or ideas. Besides having the capacity to think analytically and critically, they also need to solve problems efficiently [8].

Knowledge of fundamentals and concepts has to extend much beyond a single discipline. In addition, in today's environment where computer literacy is so essential, students need to be skilful communicators and efficient managers of intellectual property, resources and time. Lastly, a student entering a career needs to be prepared to assess progress and self.

It is up to us educators to implement a science curriculum that challenges students "to think things through", that science is experienced through the exchange and evolution of ideas, and that gender, ethnic and/or cultural issues affect this exchange.

The POGIL Research Based Learning Environment

Recent research of how the brain functions, specifically memory and how people learn gives us relevant insights into how to design such a curriculum. Namely that understanding is built on prior knowledge, experiences, skill, attitudes and beliefs. Good learners follow a cycle of exploration, concept formation and application. Concepts and multiple representations are visualized and connected. Interacting and communicating with others, especially peers, enhances understanding. Lastly, like good athletes, good learners often meditate on progress and assess their performance [9].

Process-oriented guided-inquiry learning (POGIL) uses these rigorous research findings and specific ideas about the nature of the learning process and the expected outcomes, and provides a specific methodology and structure that is consistent with the way people learn and its desired outcome: retention.

POGIL states, "that most students learn best when they are:

- actively engaged and thinking in the classroom and laboratory,

- drawing conclusions by analyzing data, models, or examples and by discussing ideas,
- working together in self-managed teams to understand concepts and to solve problems,
- reflecting on what they have learned and on improving their performance,
- interacting with an instructor as a facilitator of learning.” [1].

POGIL uses a deliberate framework to support its environment: There are seven tools, designed to develop process skills and mastery of discipline content. “Within this structure, students work together in learning teams to acquire knowledge and develop understanding through guided inquiry by examining data, models, or examples and by responding to critical-thinking questions. They apply this knowledge in exercises and problems, present their results to the class, reflect on what they have learned, and assess how well they have done and how they could do better. To reinforce the acquired concepts and to promote individual responsibility for learning, students are required to complete additional exercises and problems outside of class, and to read relevant sections of a textbook or other resource material.” [10].

An all too brief discussion of each of the seven tools is given below.

Learning teams

There is ample research documenting how students working in cooperative teams with peers benefit from the highly personalized interaction of the group [11]. The benefits include better retention, better attitudes toward the subject area, course instructor, and peers and self. In this setting, students are more likely to develop the higher level reasoning, managerial and teamwork and communication skills so prized by employers.

In the POGIL environment students are comfortable in committing the mistakes often needed for true learning to take place and misconceptions are corrected in non-threatening fashion. They correct the thought process that led to the mistake and this requires reflection. Disagreements, when handled constructively with the appropriate social skills, produce more questions, and foster an active interest in new information that leads to the desired restructuring of knowledge. One very important outcome of this approach is that in science it addresses the feelings of isolation and competitiveness experienced in college by minority and women students. Interactions with peers of all genders and races oftentimes lead to rewarding short term and sometimes life long relationships.

Guided inquiry activity

In order for learning to take place, active restructuring involving integration of new knowledge with old knowledge and beliefs on the part of the learner is required. Part of this process requires the learner to identify and resolve contradictions, generalize, infer, pose and solve problems. This makes the acquisition of knowledge very personal.

POGIL activities address this restructuring by implementing a three-stage learning cycle: *exploration, concept invention or formation and application*. This cycle follows the lessons from cognitive research that this sequence is more effective than other permutations of the three items, because it is the way we do research, underscoring the simple logic of the scientific method [12].

In exploration, a model is given for students to examine. They are led through the exploration by a series of questions or execution of tasks that produce the development of deeper understanding. Asking critical-thinking questions then further develops the functioning of the model. The answers are not self evident and require students to think about their findings in the model, what they already know and what they have learned by answering the previous questions.

In the concept invention or formation stage, students are guided to discover patterns and bring the exploration to conclusions and/or predictions about the concept by putting their findings to work. When needed and in order to preserve standard language, the instructor is the one that introduces the common-usage name.

Reinforcement of the identification and understanding of a concept is achieved in the application phase, in the form of using the new knowledge in exercises, problems and research questions.

Questions that promote thinking

Critical and analytical thinking has been defined as “an investigation whose purpose is to explore a situation, phenomenon, question, or problem to arrive at a hypothesis or conclusion about it that integrates all available information and that can therefore be convincingly justified.” [13]. For students, this desired process requires the identification of relationships and issues, identification and challenge of assumptions, formulation and answer of strategic questions. This strategy develops process skills. POGIL questions take the form of directed to point out obvious points, convergent to synthesize relationships, and divergent with no unique answers, but all are designed to model new and unknown situations that can be analyzed and made understandable by asking questions and then finding solutions.

Problem solving with expert strategies

Hayes defines a problem as “...whenever there is a gap between where you are now and where you want to be, and you don’t know how to find a way across that gap...” [14]. Structured problems are found in classrooms and textbooks, unstructured problems or real-world require a new approach, and complex unstructured problems have no unique solution and may not be solvable with available information.

POGIL grows the ability of students to solve problems. Mastery-level learning of concepts is encouraged in the exploration phase by presenting the material as a challenge, not too easy to be boring and not too difficult to be frustrating. POGIL activities are organized around key concepts in such a fashion that allows students to build a knowledge structure based on their understanding of key concepts.

The teacher has a central role as a facilitator and expert, and in the role as expert it is to present and organize concepts by scaffolding knowledge and asking pertinent questions that allow the student, as novice, to structure knowledge in an easily recallable fashion. Comparison and contrast of problems in different contexts, association bridges between different knowledge pieces, identification of patterns in representations of concepts, principles and solutions, classification of problems in terms of the concepts, principles and procedures needed to solve

them, and understanding of why the items, principles and processes are relevant are some of the expert insights that need to be explicitly taught. The expert needs to remember that all actions need to be student centered, and to allow time for the process to develop in students the depth of understanding desired.

For an instructor to model the solution to a problem is only effective if students are taught to analyze the process of arriving at the solution. This can only be achieved if the focus is on the process and not on the cookbook recipe solution. How the student got the answer is just as important as to what she/he got and why she/he got it. This needs to lead ultimately to reflection on strategy and quality in the problem solving process. Within the learning team and with other teams, discussion and feedback is shared on understanding of the problem solving process as to its effectiveness. Reflections of this nature sharpen the students' ability to grasp the essence of the problem and plan a solution. Once this is done, the instructor can always provide the "expert" way of solving the problem. Lastly and importantly, students need to be taught explicitly that in science "a picture is worth a thousand words." Notes on paper, diagrams, graphs, pictorial representations are highly valued tools when experts analyze problems, plan and implement solutions [15].

Brandsford, Brown and Cocking edited an excellent review of expert-novice research that goes much deeper into this subject [9]. Johnson and Johnson wrote about active learning and cooperation and competition [16].

The need to report publicly

The learning process is incomplete if closure is absent. POGIL provides the closure to an activity in the form of a public and a private statement by the learning team. The public statement often may take the form of individual presenters sharing their team's response to selected questions. It is accomplished by either working on the board or by exchanging spokespersons between teams. It is important that disagreements are resolved between the teams and to place the responsibility squarely on them for the learning, teaching, and assessment, and allowing for the development of the desired thought and communication processes skills to take place.

The other, the private statement, is a written report by each team to the teacher at the end of each session that includes answers to critical thinking questions, solutions to selected problems, or a summary of the important concepts that they developed. It also gives an assessment of the learning and the group dynamics. Students need to be comfortable giving each other "grades" on their communal effort and sharing these with other groups.

The need to reflect

POGIL uses metacognition as a means to make students aware that they are in charge of their own learning: they regulate and manage, they assess their performance and how they can improve on it, and they need to meditate on what they have learned and what they don't understand. POGIL designed the activities with the goal in mind that while the students work on them, they need to be thinking and asking themselves: Do I have all the information? Have I identified and validated all the assumptions? Am I using the appropriate strategy? Is there an alternative? How do I validate my answer? How on target this self-assessment is greatly

enhanced by the strategy analyst of the team making a public report sometime during the session.

Individual accountability

While POGIL activities promote cooperation and interdependence in students, applying new knowledge needs to be tested on an individual basis. Because of this while they are in the learning team mode, it is essential that instructors require high quality responses, provide very timely feedback to group work and homework, and show students when their self-assessment has produced improved performance. These is accomplished at the beginning of each activity by identifying two to three content and an equal amount of process objectives and have team members assess themselves and give a self-grade against these criteria.

Role of the Instructor

The “leader” instructor sets the learning tone by:

- ✚ lesson development and explanation,
- ✚ setting the objectives (both content and process),
- ✚ explaining expectations and criteria for success,
- ✚ setting the organization and time constraints.

The “monitor/assessor” instructor circulates throughout the classroom monitoring performance of individuals and teams

The “facilitator” instructor intervenes when needed to assure understanding and progress by questioning that identifies difficulty. These questions should go from open-ended general to directed and specific. Once the process rolls again, the instructor needs to ask few questions that allow the team to reflect on the source of the difficulty and how they solved it.

The “evaluator” instructor provides closure by asking for public reports. The evaluations given need to be given to teams and individuals as measured against the expectations and criteria for success for the activity. If general points are given they are shared with the class.

How Successful is this Approach?

POGIL was first instituted at Stony Brook in fall 1994 and student performance was tested through 1998 and compared to a comparable period before POGIL. In 1999 instructors at Franklin and Marshall College studied effectiveness of POGIL under a variety of instructional settings [17]. Another study used student performance on the 1993 ACS General Chemistry exam given as a final exam between 1994 and 2003 with data for the 2003-4 academic year after POGIL [15]. Yet another example was reported in the literature where two groups of students were compared one with POGIL the other without [9].

“Several common and important outcomes are observed in all of these studies:

- Student attrition is lower for POGIL than for traditional courses.
- Student mastery of content generally exceeds that for traditional instruction.
- Students generally prefer the POGIL approach over traditional approaches.

- Students generally have more positive attitudes about the course and the instructors.
- Student learning skills appear to improve over the semester.” [15].

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