Workshop: Process-Oriented Guided Inquiry Learning (POGIL) for Entrepreneurship
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ABSTRACT
This workshop will introduce participants to process-oriented guided inquiry learning (POGIL) in entrepreneurship, and model a POGIL activity. In POGIL, teams of 3-5 learners work on scripted inquiry activities and investigations designed to help them construct their own knowledge, often by modeling the original processes of discovery. Teams follow processes with specific roles, steps, and reports that encourage individual responsibility and meta-cognition. POGIL has been developed, and validated over the last 15 years; multiple studies have found that POGIL significantly improves student performance. Thus, POGIL provides valuable opportunities to help prepare students for E-Teams by learning both content and process skills.

Introduction
This paper includes a workshop description, general background on Process-Oriented Guided Inquiry Learning (POGIL), brief comments on the context for POGIL activities focused on entrepreneurship, and conclusions, including directions for future work.

Workshop Description
This workshop is intended for anyone interested in teaching and learning approaches that are described as active, constructivist, or discovery-based. We particularly welcome students, since they should find the POGIL activities interesting and their participation will help faculty understand POGIL’s strengths and limitations.

First, we will introduce ourselves and briefly review some relevant background (10 min). Second, participants will work through a sample POGIL activity (60 min) to understand how it works. Third, we will review POGIL’s key concepts, history, and supporting research (10 min). Fourth, if time permits, participants will begin to draft parts of new activities to review and discuss. Fifth, we will conclude with pointers to additional information and general discussion (10 min). Participants will receive copies of all slides, handouts, and other materials, and an annotated bibliography on POGIL and related topics.

This workshop will consist largely of small group work, so there should be tables with seating for teams of 3-5 participants. We will use a video projector for presentation slides, and a whiteboard, chalkboard, or large tablet of paper for other notes. Participants do not need computers, although one computer per group is useful for taking team notes.

Process-Oriented Guided Inquiry Learning (POGIL)
In POGIL, teams of 3-5 students work on scripted activities that are specifically designed to help them construct their own knowledge and understanding, often through the original processes of discovery and research (Moog
POGIL activities generally follow a 3-phase learning cycle (Abraham 2005). In **exploration**, students look for trends or patterns in models or data, and generate and test hypotheses to help understand or explain them. In **concept invention**, the patterns or hypotheses are used to define a new concept or term; ideally, students construct understanding before they learn new terminology. In **application**, the new concept is applied in other situations or contexts to help students generalize its meaning and applicability. Thus, the scripted activity provides information and asks questions to guide students through the learning cycle and help them develop process and learning skills.

Usually, A POGIL activity is organized into sections that address individual topics or sub-topics. Each section contains a series of key questions, as well as data, supporting information, and/or commentary. The activity concludes with applications that might be assigned as homework either individually or for teams. The questions in each section generally increase in difficulty, so that the activity leads students to explore new ideas, create techniques and artifacts, and then apply the ideas. Ideally, a POGIL activity requires little background and could be adapted to a variety of contexts. For POGIL activities to be readily adopted in other contexts (courses or institutions), it is helpful to define learning objectives, prerequisites, resources, and vocabulary; provide more complete background information; and package them in a standard format.

POGIL has been developed and validated over the last 15 years. Multiple research studies (Farrell, Moog, and Spencer 1999; Hanson and Wolfskill 2000; Lewis and Lewis 2005) have found that POGIL significantly improves student performance. POGIL has been used extensively in chemistry, and is also used in other STEM disciplines (De Palma 2005; Douglas and Chiu 2009; Kussmaul 2010; Kussmaul 2011).

**Context**

Although active learning and discovery learning are popular in entrepreneurship education, POGIL is not yet well known. However, POGIL’s emphasis on process skills, and the structure and support it provides for student teams, should help to prepare students to work more effectively in E-Teams. In contrast, students with limited teamwork experience often find it more difficult to adapt to E-Team environments.

The author developed and used POGIL activities and other active learning activities focused on entrepreneurship for use in two courses with different audiences and goals but with overlapping content. If You Build It... is a first-year seminar (Kussmaul 2012) intended to help students develop writing and other communication skills, targeted at students interested in the physical sciences and engineering, and incorporating content on entrepreneurship and engineering design (e.g., Dym and Little 2008). Software Engineering is a
second year computer science course that emphasizes entrepreneurship and entrepreneurial thinking (Kussmaul 2004; Kussmaul 2008).

**Example: Business Financial Spreadsheet**

This section describes an activity designed to help student teams learn how to use spreadsheets, and how and why spreadsheets can help to analyze and model a business.

First, the activity describes a lemonade stand example and notes that nearly every business involves staffing, facilities, raw materials, and publicity. (The initial example could be adapted to match the context or objectives of a specific course.) Teams are guided to open an empty spreadsheet and list expense items in one column and revenue items in another column. Teams are asked to consider which list is longer, and whether this is typical (most businesses have more categories of expenses than of revenue).

Second, teams are guided to move the list of revenue items into the first column, to add a column with an estimated dollar amount for each expense or revenue item, and to add a column rating their confidence in each estimate. These steps demonstrate how spreadsheets can be useful for tables, even without calculations.

Third, teams add formulas to compute subtotals for expenses and revenues, and to compute profit or loss. Teams then reflect on the strengths and weaknesses of this model; for example, some expenses depend on the number of employees or number of units produced.

Fourth, teams add parameters that affect their models, such as the number of employees or the number of product units produced, and adjust the expense and revenue items to use these parameters, making it easier to do “what-if” analyses for different scenarios. Again, teams reflect on the model; for example, it doesn't distinguish one-time from recurring items.

Fifth, teams add columns for successive time periods (usually weeks or months, depending on the business), parameters that change over time, and cumulative expenses, revenues, and profit/loss. Related concepts could be incorporated in a similar fashion.

Thus, the activity tries to recapitulate the evolution of a financial model so that students understand the function of each refinement. During the activity, most stages begin with exploration, lead students to invent a new concept, and then prompt teams to apply and reflect on what (and how) they are learning. Often, each stage addresses a problem or opportunity that students identified in an earlier stage, to help them see why particular concepts are relevant. Throughout the activity, the instructor circulates through the classroom to help teams as they encounter problems and to maintain an appropriate pace for the activity.

**Conclusions**

POGIL is based on learning science and has a proven track record in other disciplines. There are a variety of materials to help faculty develop and improve POGIL materials (Hanson 2005; Hanson 2006; Moog and Spencer 2008). POGIL classrooms are unlike lecture-based classrooms, but POGIL
shares characteristics with other forms of active, discovery, and inquiry learning, so that faculty familiar with such approaches should not have difficulty adapting to POGIL.

The author is developing other POGIL activities that could be used in entrepreneurship education, including activities on Stage Gate models (Cooper 2001), Story Point estimation (Cohn 2005), and elements of the Unified Modeling Language (Fowler 2003). Quantitative data is not yet available, but students appear to enjoy the activity and understand the topics more clearly than they would from reading or lecture.

Future directions for this work include extending and adapting these activities for courses and faculty at other institutions, developing additional POGIL activities, exploring the potential of supporting infrastructure, such as learning management systems or classroom response systems, and working to develop a community of faculty using POGIL in entrepreneurship.

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References


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