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POGIL IN STEM AND LABORATORY CLASSES

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I can see and hear the students constructing their own knowledge and developing scientific reasoning. That is so powerful.

—A POGIL practitioner of 11 years

The origin of POGIL in the scientific education community, specifically chemical education, set an example that many instructors in the science, technology, engineering, and mathematics (STEM) disciplines have adopted. POGIL practitioners are present across STEM, including chemistry, biology, clinical and health sciences, mathematics, engineering, computer science, and environmental science. This chapter explores the use of POGIL in STEM classrooms and labs. First, we discuss the connection of POGIL methods with common conceptions of the scientific method, including models of how scientists work, as described in the Harwood model and other contemporary accounts. Second, we briefly describe the spread of POGIL in the STEM classroom, also taking note of the recent expansion of POGIL into the laboratory environment and closely related methods, such as the science writing heuristic (SWH). Finally, we present a vignette showing an exemplary implementation of POGIL in both an undergraduate chemistry setting and a professional pharmacy program.

Why Are POGIL Methods Particularly Well Suited to STEM?

As discussed in Part One, the POGIL method is an effective guided-inquiry strategy with a proven track record for enhancing student learning. In addition, the guided-inquiry method of teaching matches well with the inquiry necessary for conducting science (Lamba & Creegan, 2008). As described in Part One, the term *inquiry* has two different meanings when applied to pedagogy and scientific research. Inquiry methods in the POGIL model follow the learning cycle components of exploration, concept invention, and application and require students to make use of a set of process skills to learn the relevant material. The learning cycle matches well to the traditional model of the scientific method. In the exploration phase, the activity provides and asks questions about a phenomenon and leads to concept invention, analogous to analyzing data and developing a hypothesis. Students then move on to application, or hypothesis testing, and ask more questions. However, as determined by Harwood, Reiff, and others (Harwood, 2004; Harwood, Reiff, & Phillipson, 2002; Reiff, Harwood, & Phillipson, 2002), inquiry in scientific research is a more open-ended process, and POGIL can help students develop this thinking skill as well. In this section, we explore and compare the parallels between scientific inquiry and guided-inquiry learning.

In the cited research, the authors surveyed more than 50 research scientists from 9 departments in a large research university about their conception of scientific inquiry. Although expecting to receive discipline-specific responses, they instead found commonality among scientists' responses regarding the characteristics of a scientific investigator and a scientific investigation. The single characteristic most frequently mentioned is the ability to make connections among ideas and among disciplines. In addition, scientific investigation should be fueled by questions posed by the investigator, a process focusing on the investigation and not the end result; that is, the investigator must be willing to be wrong and to be open to unexpected results, like good problem solvers.

Based on their findings, Harwood (2004) developed a conceptual model called the activity model to describe scientific inquiry more authentically. A version of this model by Robinson (2004) is shown in Figure 11.1. Central to this model is asking a general question. This questioning is a divergent process that drives the inquiry. Connected to this central process of asking questions are nine other characteristics identified by the researchers (Harwood, 2004; Harwood et al., 2002; Reiff et al., 2002). These other characteristics are common in scientific research and are all connected to each other and to the central activity of asking questions. They include items such as defining the problem, examining the results, reflecting on the findings, and communicating with others. These characteristics resemble what many textbooks refer to as the scientific method, but they differ in several key ways. The activities are not in a prescribed linear or cyclic order. Instead, they represent activities that are conducted in whatever order is appropriate for the area of research. Furthermore, the list is not intended to be comprehensive, but rather it lists those items that are common across a wide range of science and engineering disciplines.