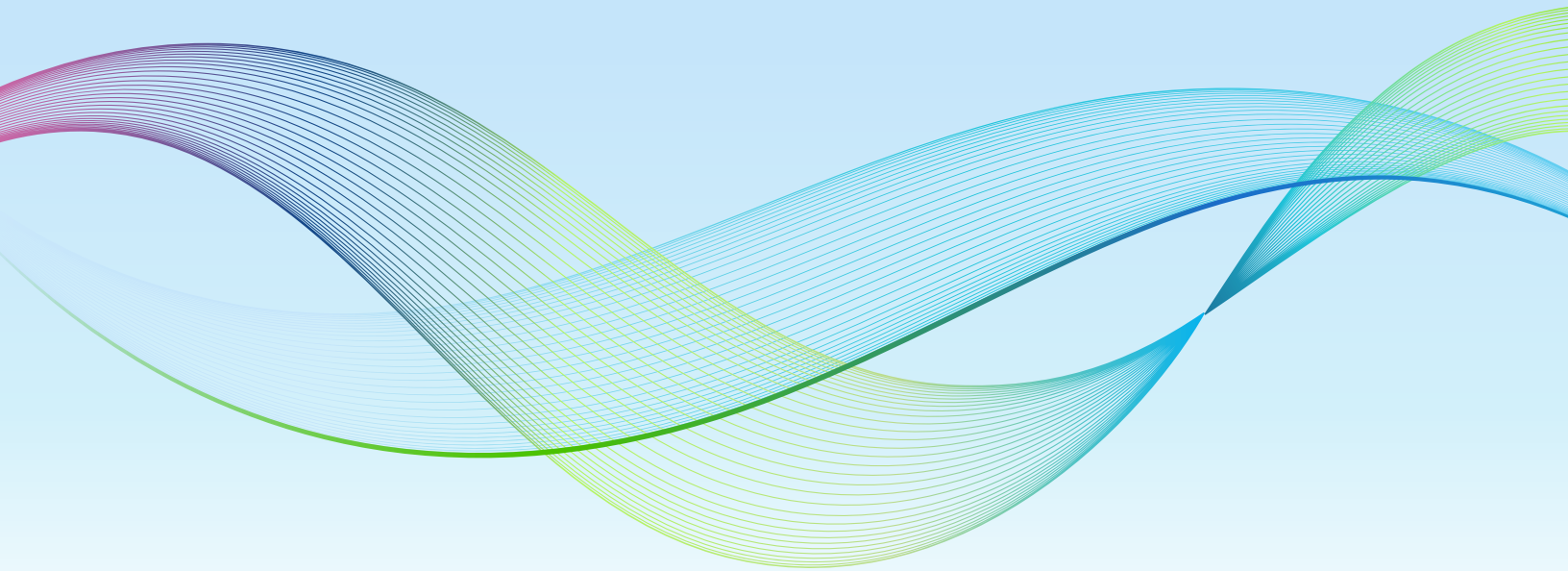
POGIL®

PROCESS ORIENTED GUIDED INQUIRY LEARNING



IMPLEMENTATION GUIDE

Getting Started

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This POGIL Implementation Guide is designed to help you get started teaching with POGIL and to get the most impact out of the POGIL activities!

1

Introduction

WHAT IS POGIL?

POGIL is an acronym for **Process Oriented Guided Inquiry Learning.** It is a teaching/learning pedagogy and The POGIL Project is an active professional community. The learner-centered pedagogy evolved in the chemistry classrooms of Rick Moog, Jim Spencer, and John Farrell at Franklin & Marshall College in the early 1990s, and was adapted from the myriad chemistry and physics education reforms taking place at the time. The Project has grown beyond chemistry and STEM to include an active community of thousands of international teachers in a broad spectrum of disciplines at all educational levels.

POGIL takes place in a structured environment in which students work cooperatively in self-managed teams of three or four. They work on carefully crafted guided inquiry activities that are scaffolded to help students master content and develop life and learning skills – what we call process skills.

POGIL is based on four guiding principles:

1. **Constructivism** – students create their own knowledge
2. **Inquiry**–exploring models and developing concepts
3. **Cooperative learning** – use of roles, interdependence, and individual responsibility
4. **Process skill development** – assessment, communication, critical thinking, information processing, management, problem solving, and teamwork.

POGIL activities provide students with data or information followed by leading questions designed to guide them toward formulation of their own valid conclusions. Questions also guide students to use and develop process skills. The instructor serves as a facilitator and guides the process–observing and periodically addressing individual and classroom-wide needs. However, the POGIL pedagogy is not rigid and every classroom in which it is used is different and reflects the appropriate situational factors of the students, instructor, classroom, department, and institution.

WHY SHOULD I USE POGIL?

POGIL is based on research into how people learn:

1. **Teaching by telling is not particularly effective.**
2. **Students learn best when they construct their own understanding.**
3. **Learning is a fundamentally social act.**
4. **Knowledge is personal.**

Students generally enjoy themselves more and develop greater ownership of the material when they are given the opportunity to construct their own understanding. The POGIL environment emphasizes that learning is not a solitary task of memorizing information, but an interactive and iterative process of refining one's understanding and developing skills. Students quickly get the message that logical thinking and teamwork are more valuable than simply "getting the right answer." It energizes students and instructors. In addition, facilitating POGIL activities provides instructors with instant and constant feedback about what their students understand and misunderstand.

WHEN AND WHERE DO I USE POGIL?

POGIL activities are specifically designed to introduce students to content, help them develop key concepts, and apply those concepts. It is particularly useful for introducing difficult or complex concepts, developing deep understanding, and rectifying misconceptions. Students are generally not expected to have done any work prior to coming to class and the facilitator does not have to provide extensive background information. Teams of students in the classroom complete activities and after class work may include additional application and knowledge extension exercises.

POGIL activities are also specifically designed to elicit process skills, often referred to as professional or soft skills. Question design, targeted questions, and instructor facilitation help students identify, learn, and use these skills.

HOW DO I USE POGIL?

One of the key facets of POGIL is that it is student-centered and lecture is not the dominant mode of instruction. This requires many teachers to shift their approach to a facilitation perspective as opposed to a knowledge provider role. The instructor's role is no longer to simply deliver content to the students; rather, it is to facilitate student learning and growth. Students learn more when they appropriately struggle to develop their own knowledge.

The POGIL Project

The POGIL Project is a nonprofit 501(c)(3) organization that brings together like-minded educators who wish to effect change within education. It works to disseminate its unique pedagogy, POGIL, at the secondary and college levels through professional development workshops as well as the production of curricular materials.

We envision an educational system that prepares every learner to enrich the world by thinking critically, solving problems, working effectively with others, and experiencing the joy of discovery.

The mission of The POGIL Project is to improve teaching and learning by fostering an inclusive, transformative community of reflective educators who design, implement, assess, and study learner-centered environments.

FOUNDATION AND VALUES

The way in which we intend to transform education evolves from a set of foundational ideas established by research and a set of community values developed through practice. Together these elements define how we approach teaching and learning.

The foundational ideas for POGIL are that:

- Learners construct their own knowledge.
- Learners negotiate meaning actively through student-student discourse in self-managed teams within an instructor-facilitated environment.
- Effective learning in a team emerges from attending to cooperative learning principles and process skills development.
- Reflection and assessment enhance individual learning, team function, and teaching practice.

The shared practices valued by The POGIL Project community include:

- Using inquiry-based learning materials, which are structured following the explore/invent/apply learning-cycle model.
- Intentionally developing content knowledge and process skills simultaneously in the learning environment.
- Interacting and collaborating within and across educational levels and disciplines.
- Incorporating insights from educational research that have implications for classroom practice.
- Creating inclusive learning environments for students and instructors. Being personally invested in encouraging and supporting the professional development of colleagues.

ASK THE EXPERT

Why teams of 3 or 4 students?

Group work requires robust collaboration. Too few and students can get stuck; too many and the group can fracture and allow social loafing.

Students work in learning teams, generally with 3-4 students sitting together to encourage a cooperative environment.

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Learning Teams

COOPERATION REQUIRES A TEAM OF LEARNERS

The effectiveness of your classroom is enhanced when it becomes a community of students collaborating and learning from each other. Collaboration in a POGIL classroom occurs in many ways and the first is within the 3-4 person learning team. As a team, students are more likely to acquire critical thinking, analytical thinking, teamwork, and communication skills – skills that are essential in the workplace. Since this is the main learning configuration in POGIL classrooms, learning team formation is an important first task.

Forming a Learning Team

There is no best way to group students into a learning team. Even though students often prefer to choose their own teams, instructor-assigned teams usually increase effective collaboration and productivity. Criteria to consider when forming teams include what is important for success in your classroom and the level of desired diversity (heterogeneity vs. homogeneity). Studies suggest that diversity in academic achievement level, gender, and ethnicity all have a positive impact on team learning.

There are distinct compositions of high-functioning teams that must be established by the instructor, because they are not likely to occur naturally. Given the wide range of student characteristics, it can be helpful to become familiar with tools and methods for group construction.

Some of the methods facilitators employ for team formation include:

- Assigning teams randomly, particularly when you do not know the students.
- Assigning teams based on ability, performance or background. It is up to the instructor to decide what the most important diversity criteria are and to use them to group students. For example, in a course where some students might have prior knowledge, it is appropriate to spread that knowledge amongst the teams.

Students perform specific assigned roles within their teams.

Cooperative learning has a large base of research spanning more than 20 years that supports the effectiveness of cooperative learning strategies for improving learning as compared to individualistic or competitive learning structures. One necessary component of a successful cooperative learning structure is creating positive interdependence within a team of learners. One strategy to achieve positive interdependence is the assignment of roles to individual learning team members.

POGIL PRACTITIONER ADVICE:

If a team is not working, you can always adjust the team members. Try changing team composition frequently at first, so students get to know each other. Over time, you may not change the students as often. If a team is working well, leave it in place!

The use of student roles is a hallmark of the POGIL pedagogy and optimal implementation of this learning strategy is dependent upon their use. Many practitioners believe roles are the real key to having a positive classroom experience with POGIL, particularly in the high school setting. Because of the broad range of cognitive and social skill levels that exist within any given group of teenage students, it is essential to clearly define and provide instruction about the appropriate, pro-social behaviors associated with working in cooperative teams. Using roles reduces the stress level, so teams can focus more on the content and process skills. It gives the student a roadmap for how they should be interacting with their learning team. The use of roles can also improve student participation. For example, the shy or unsure student acting as a presenter does not have to share their own ideas; rather, they are reporting their team's response and this can feel less threatening.

There are many names for the same role – you can decide which names work best in your classroom. Because the typical team consists of four members, choose four roles that are needed for a particular activity. If you have one team of three, one person may have to carry out the job of two roles. However, if you are using teams of three, then only create three roles. Roles should rotate so students can experience teamwork (process skill) from different viewpoints. **Table 1** describes the most commonly used roles. For a set of downloadable POGIL role cards, visit this link (www.pogil.org/resources).

OPTIMIZING THE USE OF ROLES

Students are not going to effectively complete POGIL activities and work in teams on the first day of class. Most have never done this type of learning work before. Help them by starting at the beginning of the year and using POGIL often enough that the students do not forget how to use roles, work in teams, think for themselves, complete activities, etc. Because roles are new to students, they need to be explained and students must be trained to use the roles. Use roles consistently and pervasively from the first day to the end of the school year and continually reinforce their use. It may be useful to provide

ASK THE EXPERT

How important are student roles?

Enforce the roles! The use of roles helps students stay on task, improves interpersonal interactions, aids process skill development, and encourages sharing of leadership throughout the academic term.

TABLE 1. DESCRIPTION OF ROLES

ROLE	DESCRIPTION
MANAGER	Manages the team. Ensures that members are fulfilling their roles, that the assigned tasks are being accomplished on time, and that all members of the learning team participate in activities and understand the concepts.
PRESENTER	Communicates for the team. Asks team questions and clarifications of the teacher or other teams. Ensures that all team members have had a chance to respond before asking outside sources. Ensures that everyone in the team agrees on what to ask if an outside source is needed. Presents conclusions of the team to the class, as requested.
RECORDER	Records the names and roles of the learning team members at the beginning of each activity. Records the important aspects of the learning team's discussions, observations, insights, etc. The recorder's report is a log of the important concepts that the team has learned.
REFLECTOR	Observes and comments on learning team dynamics and behavior with respect to the learning process. These observations should be made to the manager on a regular basis in an effort to constantly improve team performance. The reflector/analyst may be called upon to report to the team (or the entire class) about how well the group is operating (or what needs improvement) and why.

students with role cards describing the roles; to point out positive examples of behavior when they occur; to have a class discussion/lesson on roles; to practice the roles; and to provide rationales for using the roles.

While teams may remain together for weeks or months, regular rotation of roles within each team is very important to participation, effective learning, and the development of group process skills. Having students change roles after a day or two ensures that all students have the chance to perform the functions with which they are most comfortable and to build on the skills they may find more challenging. This role rotation encourages shared leadership and enhances team effectiveness.

POGIL PRACTITIONER ADVICE:

Show these videos (https://pogil.org/educators/resources/interpersonal-effectiveness-videos) to demonstrate roles and skills needed to work successfully in a learning team. This page contains links to more than 40 videos created through the POGIL/HACH Northern Colorado Consortium. The videos were designed as instructional tools to help students better understand the importance of effective interpersonal skills in teamwork. The brief vignettes show both positive and negative examples of interactions between students, providing a starting point for class discussion on student roles and appropriate behavior in learning team situations.

A COOPERATIVE ENVIRONMENT

The physical setting of a POGIL classroom can vary, depending on the limitations of the space. Some classroom spaces are easier to use than others, but all can be made to work. The classroom arrangement should be considered when planning for implementing POGIL. Ideally, the instructor can move easily amongst the teams. It is helpful if students can face each other so that eye contact is possible while talking to each other. They should also have a reasonable surface to write on. In addition, if possible, try to set up your classroom so that there is no direction or "stage" during group work situations.

However, not all spaces are perfect. For example, if your POGIL classroom is a lecture hall, it probably is best to have teams of three, seated together, which will allow for better communication between and among the team members without leaving the people at the far ends out.

Whatever your classroom configuration is, make a plan for the room—draw a configuration and develop a procedure for re-arranging the desks and tables if you need a quick turnaround time. This also helps you assign team locations and get to know student names at the beginning of the term.

ASK THE EXPERT

Does POGIL work in large classes?
POGIL has been used successfully in classes of 200 or more. *Consider:*

- **Arrange teams so that members can collaborate easily and so that the teacher can get close to every group.**
- **Report out with just a few teams, particularly if their answers are consistent.**
- **Simplify or automate reporting with tools or technology.**
- **Decrease team size to 3 to improve collaboration with fixed auditorium seating.**
- **Use student facilitators as assistants.**
- **Before using a new activity, try to pilot it with a small group to find and fix problems.**

TIPS TO IMPROVE TEAM FUNCTIONING AND CLASSROOM ENGAGEMENT:

- Avoiding isolating students (gender, ethnicity, etc.). Being mindful of diversity and inclusion is very important in team formation.
- Using the roles within the team and ensuring that students know why the roles are important in helping to develop the process skills and encouraging positive interdependence.
- Using a variety of different reporting out methods: clicker questions, posters, writing on the board, oral reports, or activities where teams move around or manipulate physical objects.
- Occasionally remind students that POGIL will help them develop important process skills that are required in most careers and relationships.

3

POGIL PRACTITIONER ADVICE:

Activities are designed to introduce students to concepts. Do not be tempted to prep them with reading or lecture!

POGIL Activities

The activities that students complete in class are specially designed for POGIL implementation.

POGIL activities are specially designed to guide students in the construction of their own content knowledge and to develop important process skills through collaborative work. The activities are developed around two or three learning objectives that include both content and process skills. They also use models that direct student learning by asking various exploration questions that lead to the construction of knowledge and concept invention through a Learning Cycle. POGIL activities may look like homework activities or worksheets but they are to be used in a classroom setting with a facilitator present and the students working in teams.

THE MODEL

All POGIL activities begin with a model. The model is developed around the learning objective of the activity. A robust model should include sufficient information and examples for students to reach the desired conclusion. It may show relationships, comparisons, processes, and/or changes over time. The model might be a clearly labeled diagram, graph, data table, sample text, etc. - whatever an expert would use to make decisions and learn about a topic. Regardless of the form, the model is the foundation for the construction of knowledge and the development of the process skills as students collaborate.

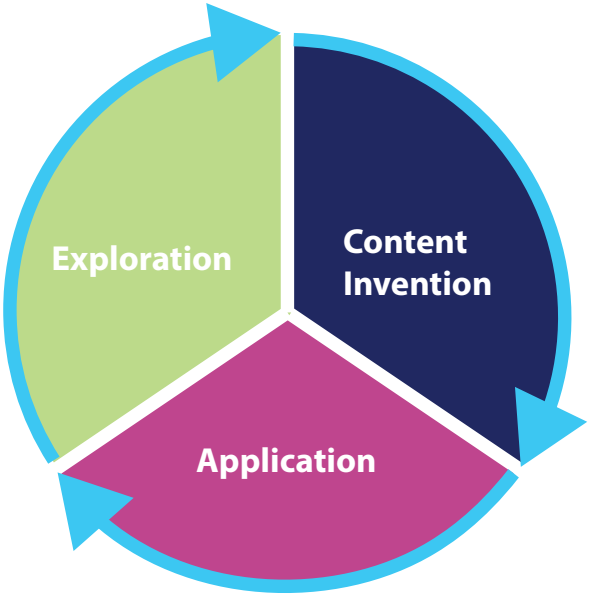
CRITICAL THINKING QUESTIONS

The bulk of the activity involves the students working on questions that follow the Learning Cycle. The Learning Cycle can be described by three phases:

1. Students explore a robust model.
2. Students develop an understanding through concept invention followed by term introduction.
3. Finally, students apply their newly constructed knowledge to a new situation, achieving a deeper understanding of the concept.

This Learning Cycle parallels the scientific method and provides the context for introduction of new terms. It explicitly provides opportunities for critical thinking. Students are encouraged to move from inductive thinking during the exploration phase to deductive thinking as they move into and through the application phase.

THE 3-PHASE LEARNING CYCLE



USE THE ACTIVITY STRUCTURE TO SCAFFOLD YOUR FACILITATION

Using a teacher's guide or implementation guide will help you plan and successfully incorporate the activity in your class. Some activities include specific markings such as "STOP" and "KEY."

Keys mark the question(s) where the student should have invented or be beginning to invent the content knowledge and directly tie back to the learning objectives. The facilitator can draw particular attention to those questions during reporting out sessions.

Stop signs mark a stopping point in the Learning Cycle or in the development of a concept. This is a good time for the student to stop working on the activity and for the instructor to have the students report out or have a follow up discussion with the whole class.

TIPS TO IMPROVE IMPLEMENTATION OF POGIL ACTIVITIES:

- Models can be whatever experts analyze to learn about the content.
- Make sure the students do all the questions in order.
- Do not skip the "easy" questions or lecture over them, it is important to the learning cycle to answer all questions.
- It is not a race! Encourage the students to answer all questions thoughtfully and in complete sentences.
- All the information to answer the questions is in the model! Students work on the activity only during class time with a facilitator present.

POGIL PRACTITIONER ADVICE:

Annotate the activity for process skills when preparing your facilitation plan. Identify the process skill, how it is used, and facilitator prompts that can help students identify and use that skill.

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Process Skills: They're in the Name

An increasingly global and technology-driven economy has increased the importance of developing skills such as communication, creative thinking, leadership, management, metacognition (learning how to learn), problem solving, and teamwork. A significant factor that sets POGIL apart from other active or group learning methods is the specific incorporation of these skills – what The POGIL Project terms **process skills.** Process skills are often referred to as soft skills or life skills in other contexts. *These are so critical to POGIL that it is in the name, Process Oriented . . .*

POGIL makes understanding and developing these skills for the workplace and for life an integral part of the student learning process. Engaging in these processes is also crucial for student success in active learning environments. The seven process skills intentionally targeted by POGIL are defined in Table 2. Well-written activities, dedicated use of roles within the teams, and intentional facilitation will draw out and reinforce these skills.

ACTIVITIES ARE DESIGNED TO REINFORCE PROCESS SKILLS

The design of POGIL activities promotes process skills, specifically **problem solving** and **critical thinking**, as students analyze a model and invent concepts. The activity may also include prompts that require students to summarize in writing and/or orally to promote **communication skills**. In addition, an activity that is challenging enough will encourage students to work together and enhance **teamwork.** (However, if an activity is too challenging, student teams may become frustrated and unable to complete the activity at all.)

USE OF TEAMS IS CRITICAL FOR PROCESS SKILLS

The intentional use of student teams in the POGIL classroom encourages **teamwork, communication,** and **management.** The assignment and enforcement of student roles further enhances teamwork, communication, and management skill development as students fulfill the duties of various roles. Routinely rotating the roles requires that students learn/perform different jobs and skills and allows students to focus on developing a limited skill set at one time.

TIPS TO IMPROVE PROCESS SKILL DEVELOPMENT:

- Include process skill prompts in the activity.
- Create a facilitation plan that includes both how to help students learn the content and develop process skills.
- Elicit, point out, assess, and provide feedback about process skills.
- Assign and enforce team roles.
- Use assessments that require students to practice process skills.

TABLE 2. POGIL PROCESS SKILLS DEFINITIONS

PROCESS SKILL	OPERATIONAL DEFINITIONS
ASSESSMENT (Self-Assessment and Metacognition)	Self and Peer Assessment: Gathering information and reflecting on experiences to improve subsequent learning and performance. Metacognition: Thinking/reflecting about one's thinking and how one learns, and being aware of one's knowledge.
CRITICAL THINKING	Analyzing, evaluating, or synthesizing relevant information to form an argument or reach a conclusion supported with evidence.
INFORMATION PROCESSING	Evaluating, interpreting, manipulating, or transforming information.
MANAGEMENT	Planning, organizing, directing, and coordinating one's own and others' efforts to accomplish a goal.
ORAL AND WRITTEN COMMUNICATION	Oral Communication: Exchanging information and understanding through speaking, listening, and nonverbal behaviors. Written Communication: Conveying information and understanding to an intended audience through written materials (paper, electronic, etc.).
PROBLEM SOLVING	Identifying, planning, and executing a strategy that goes beyond routine action to find a solution to a situation or question.
TEAMWORK	Interacting with others and building on each other's individual strengths and skills, working towards a common goal.

GOOD FACILITATION ENHANCES PROCESS SKILL DEVELOPMENT

Facilitation is also critical in helping students develop these process skills. A facilitation plan helps the instructor identify the process skills developed within the activity. This gives the facilitator the opportunity to prepare for eliciting, monitoring, and providing feedback on those skills as students work on the activity. This aspect of preparing the facilitation plan includes reviewing the activity and identifying the prompted process skills and how those can be reinforced, observed, and assessed as students work. With the facilitation plan in mind, the facilitator can then monitor, intentionally provide instruction, create opportunities for improvement, and give feedback to help students develop their process skills in the classroom.

Lastly, it does no good to encourage the development of process skills if the assessments do not require the use of them. Assessing and providing feedback about students' development and use of process skills not only helps students develop these skills, but to also understand the importance of obtaining and practicing these skills. There are both student and instructor rubrics available to guide this assessment and feedback. In addition, assessment opportunities should include questions and prompts that elicit process skills. For example, a test question might require that students interpret a graph that they have not seen before.

ASK THE EXPERT

How do I cover the required content?

As teachers, we have pressure to cover more content each year. A POGIL activity often takes more time than a lecture on the same content, but as teachers we should focus on outputs (what is learned), not inputs (what is covered). Topics usually contain several related concepts; students who truly understand one key concept often find it much easier to learn related concepts. Many studies have found that POGIL students perform better than lecture students on standardized exams and even on exams written by the lecture teacher.

POGIL PRACTITIONER ADVICE:

Try to intervene on process, not content! The students should not look to you for answers when they are stuck! We want them to become independent learners and resilient.

A skilled facilitator will answer a question with additional questions that guide the students to the answer.

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ASK THE EXPERT

Do I grade the activities?

Activities are not assessment. Focus should be on active participation and process skills. However, some instructors may occasionally collect one team member's activity to encourage participation and positive interdependence.

Pedagogy

THE POGIL PEDAGOGY IS STUDENT-CENTERED AND ACTIVE

POGIL developed out of a desire to help students succeed. The POGIL pedagogy is not an instructor-centered, lecture-heavy style of teaching. Instructors no longer think about what they are going to say, but instead they focus on what students say. They work to help students develop their own understanding and the ability to apply concepts. The instructor predominantly serves as a facilitator of student learning and not as the primary source of information.

Students need to understand why the class is structured differently than a lecture-based class. It is useful to do an introductory activity that helps students understand that building their own knowledge is a more effective way of learning and will lead to long-term success. The POGIL activity replaces lecture material, demonstrates how experts think about the content, and provides the students with a self-generated study guide.

POGIL activities are not designed to be used as a worksheet, as homework, or as a substitute teacher's lesson plan. Rather, they are designed to introduce students to critical concepts, deepen understanding of those concepts, and to help students apply those concepts. Effective facilitation is critical to effective student learning.

TIPS FOR PREPARING YOUR FACILITATION BEFORE CLASS:

- Define course and daily learning outcomes.
- Assess student prior knowledge.
- Identify appropriate learning activities/tasks.
- Plan student team structure.
- Prepare intentional warm-up plans for daily activities.

THE FACILITATOR IS AN "ACTIVE" PARTICIPANT

Your facilitation of a POGIL activity during class is a very important part of effective implementation. Students are more likely to achieve the desired outcomes when you prepare carefully before facilitation.

POGIL activities may look like homework activities or worksheets but they are meant to be used in a classroom setting with an instructor present and the students working in teams. They should be completed under your close supervision. It takes time to plan the class, decide when and where to check for understanding, what process skills are being emphasized, and choose when to have students report out important answers. Facilitating POGIL activities requires the instructor to have a clear understanding of the concepts and process skills and to be able to "think on their feet" to help students arrive at the desired destination.

ASK THE EXPERT

How do I get attention of teams and students?

This can be done in many ways:

- **The most common is that the teacher raises their hand, and each student raises their hand when they see a raised hand.**
- **The teacher claps or taps a pattern. Students repeat the pattern when they hear it.**
- **The teacher rings a bell, gong, or buzzer.**

It is very important that you move around the room, listening to team discussions and monitoring team progress. It will become obvious if a team is struggling or interacting poorly. It is your job to encourage and ask guiding questions to help the team move forward. For a team that has progressed beyond the others, you may stop at that team's table to ask probing questions or you may send them to another table to compare work. It requires intentional effort and time management to keep teams on task and moving smoothly. Teams that consistently use the team roles work more efficiently and effectively. Facilitation is ACTIVE!

Periodically reporting out is an essential tool in the POGIL classroom. When key convergent questions are discussed, it reassures students that they are on the right track. Reporting out also provides deadlines and helps teams manage their time and keep up. Divergent questions can be discussed to help students see different views and ideas, and to encourage thinking and discussion. We want to report individually to see if all team members understand concepts. However, in large classes, there may not be time for every team to report out for each question, but each team should report out at least once during each class meeting.

Do not get discouraged if you encounter difficulties as a facilitator. It takes time to master new skills for new methods.

TIPS FOR PRODUCTIVE FACILITATION IN CLASS:

There are many approaches to reporting out.

- Establish daily routines
- Set the pace and post time cues
- Provide real-time feedback
- Interact with students equitably and productively
- Support students' emotional responses
- Supply resources to support social skills

TIPS FOR REPORTING OUT:

There are many approaches to reporting out.

- Have each team orally present their team's answer to a question.
- Have each team write their answer on the chalkboard or whiteboard.
- Give each team a small chalkboard or whiteboard to write their answer. This is especially useful for drawing (e.g. chemical structures).
- Give each team a set of cards with different colors, letters, or numbers, and have them hold up the card corresponding to their answer.
- Have one team member move to another team to compare answers, then report back to the original team and change answers if needed.
- Use technology such as clickers or web-based reporting systems, which can show individual responses or summarize data to show patterns.

AFTER CLASS

Compare your short-term learning outcomes to the course and lesson learning outcomes as you plan for the next class period.

Reflect on your facilitation and your students' learning. What were strengths of the day and why were they strengths? What are opportunities for improvement and how can the improvements be made? What insights into teaching, learning, etc. did you gain today?

Because POGIL is different from what most students, and their parents, are used to experiencing in the classroom, you may find some initial resistance. Just as in many endeavors, frequent and clear communication with all stakeholders is important here. Helping learners understand that this is actually a more effective pedagogy and that the increased classroom work will result in improved performance encourages most to give POGIL a chance. Once they do, most buy in.

POGIL PRACTITIONER ADVICE:

With a good activity, most teams will stay focused and engaged on their own. Restless teams may be a sign that the activity can be revised and improved. Also, consider adding variety with more or different reporting out, mini-lectures, or activities where teams move around or manipulate physical objects.

TIPS FOR INCREASING BUY IN AND REDUCING RESISTANCE:

- Create a supportive environment in which POGIL is the norm.
- Explicitly reveal aspects of POGIL pedagogy.
- Show the data. POGIL is usually better than lecture, but no approach to learning is 100% effective. Remind students that they will learn more in a team than working alone, perhaps by starting the term with an activity that focuses on teamwork.
- Create a safe learning environment.
- Provide incentives for meaningful participation. Empower students to shape some aspects of the class.
- Emphasize the process skills. Remind students that POGIL will help them develop teamwork and other process skills, which are required in most careers and professional work.
- Use roles. Some students have had bad experiences with teams, because work was not shared equally. Remind students that POGIL activities and roles are designed to engage all members equally, and that each member will rotate through each role.
- Incorporate "redemptive grading" to increase mastery and decrease anxiety.
- Cultivate buy in from third parties.

ASK THE EXPERT

Do I need to do this every day?

No. However, using POGIL methods at regular intervals gets students used to the routine and improves the learning teams and the outcomes!

Selected References

Abraham, M.R. (2005). Inquiry and the learning cycle approach. In N.J. Pienta, M.M. Cooper, & T.J. Greenbowe (Eds.) *Chemists' Guide to Effective Teaching: Volume I* (pp. 41-52). Upper Saddle River, NJ: Pearson Prentice Hall.

Brown, P.J.P. (2010). Process-oriented guided-inquiry learning in an introductory anatomy and physiology course with a diverse student population. *Adv Physiol Educ,* September, 34:150-155.w

Brown, S.D. (2010). A Process-oriented guided inquiry approach to teaching Medicinal Chemistry. *Amer J Pharm Educ*, 74(7), article 121.w

De Gale, S. & Boisselle, L. (2015). The Effect of POGIL on academic performance and academic confidence. *Sci Educ Intl*, 26(1), 56-79.

Eberlein, T. Kampmeier, J., Minderhout, V., Moog, R.S., Platt, T., Varma-Nelson, P. & White, H.B. (2008). Pedagogies of engagement in science: A comparison of PBL, POGIL, and PLTL. *Biochem Molec Biol Educ*, 36, 262-273.

Farrell, J.J., Moog, R.S., & Spencer, J.N. (1999). A guided inquiry Chemistry course. ***J Chem Educ,*** 76, 570-574.

Gehrke, S. & Kezar, A. (2016). STEM reform outcomes through Communities of Transformation. *Change,* January/February 2016, 30-38. http://www.change.org

Hale, D., & Mullen, L.G. (2009). Designing process-oriented guided-inquiry activities: A new innovation for Marketing class. *Market Educ Rev,* 19, 73- 80.

Hanson, D., and Wolfskill, T. (2000). Process workshops - A new model for instruction. *J. Chem. Educ.*, 77, 120-130.

Hinde, R. J. & Kovac, J. (2001). Student active learning methods in Physical Chemistry. *J Chem Educ,* 78, 93-99.

Hu, H. & Avery, B. (2015). CS Principles with POGIL Activities as a Learning Community. *J Comput Sci College*. 31(2), 79-86.

Hu, H.H. & Shepherd, T.D. (2013). Using POGIL to help students learn to program. *Transact Comput Educ,* 13(3) Article 13 (August 2013), 23 pages.

Hughes, P. & Ellefson, M. (2013). Inquiry-based training improves teaching effectiveness of biology teaching assistants. *PLOS ONE*. Retrieved from https://journal.plos.org/plosone/article?id=10.1371%2Fjournal.pone.0078540

Karplus, K., and H.D. Their. (1967). *A New Look at Elementary School Science*. Chicago: Rand McNally.

Kulatunga, U., Moog, R., & Lewis, J. (2014). Use of Toulmin's argumentation scheme for student discourse to gain insight about guided inquiry activities in college Chemistry. *J College Sci Teach*, 43(5), 78-86.

Lewis, S.E. & Lewis, J.E. (2008), Seeking effectiveness and equity in a large college Chemistry course: An HLM investigation of peer-led guided inquiry. *J Res in Sci Teach*, 45, 794-811.

Lewis, S.E., & Lewis, J.E. (2005). Departing from lectures: An evaluation of a peer-led guided inquiry alternative. *J Chem Educ,* 82(1), 135-139.

Maurer, T. (2012). Adapting process-oriented guided-inquiry learning (POGIL) to Family Science. *Nat Council Family Relat*, 57(2), F29-F30.

Maurer, T. (2014). Process-oriented guided-inquiry learning in Financial Literacy education. *Forum Family Consum,* 9(1), 1-17.

Mitchell, E. & Hiatt, D. (2010). Using POGIL techniques in an IL curriculum. *J Acad Librarian,* 36(6), 539-542.

Moog, R.S. (2014). Process oriented guided inquiry learning. In M. A. McDaniel, R. F. Frey, S. M. Fitzpatrick, & H. L. Roediger (Eds.), *Integrating cognitive science with innovative teaching in STEM disciplines*. St. Louis: Washington University in St. Louis Libraries.

Moog, R.S., & Spencer, J.N. (Eds.). (2008). *Process-Oriented Guided Inquiry Learning: ACS Symposium Series* 994. Washington, D.C.: American Chemical Society.

Moog, R.S., Creegan, F.J., Hanson, D.M., Spencer, J.N., & Straumanis, A.R. (2006). Process-oriented guided inquiry learning: POGIL and the POGIL Project. *Metrop Univ,* 17, 41-51

Moog, R.S., Creegan, F.J., Hanson, D.M., Spencer, J.N., Straumanis, A., Bunce, D.M., & Wolfskill, T. (2009). POGIL: Process-oriented guided-inquiry learning. In N.J. Pienta, M.M. Cooper, & T.J. Greenbowe (Eds.) *Chemists' Guide to Effective Teaching: Volume II* (pp. 90-107). Upper Saddle River, NJ: Prentice Hall.

Olivieri, L.M. (2013). Piloting POGIL in an introductory Python programming course. *J Comput Sci College* 28(6), 194-195.

Rasmussen, C., & Kwon, O. (2007). An inquiry oriented approach to undergraduate mathematics. *J Math Behav*, 26, 189-194.

Rasmussen, C., Kwon, O., Allen, K., Marrongelle, K., & Burtch, M. (2006). Capitalizing on advances in mathematics and K-12 mathematics education in undergraduate mathematics: An inquiry-oriented approach to differential equations. *Asia Pacific Educ Rev,* 7, 85-93.

Schroeder, J.D. & Greenbowe, T.J. (2008). Implementing POGIL in the lecture and the science writing heuristic in the laboratory - Student perceptions and performance in undergraduate Organic Chemistry. *Chem Educ Res Pract*, 9, 149.

Sen, S., Yilmaz, A., & Geban, Ö. (2015). The effects of process oriented guided inquiry learning environment on students' self-regulated learning skills. *Probs Educ 21st Cent,* 66, 54-65.

Simonson, S. & Shadle, S. (2013). Implementing process oriented guided inquiry learning (POGIL) in undergraduate Biomechanics: Lessons learned by a novice. *J STEM Educ,* Volume 14 (Issue 1), 56-63.

Simonson, S.R. (Ed) (2019). *POGIL: An Introduction to Process Oriented Guided Inquiry Learning for Those Who Wish to Empower Learners*. Sterling, VA. Stylus Publishing.

Soltis, R. (2015). The use of POGIL teaching strategy increases student learning of basic Pharmacology concepts. FASEB J, 29(1).

Spencer, J. N. (2001-2002, Winter). From traditional to radical: One teacher's odyssey. *Thought Action*, pp. 93-100.

Spencer, J.N. (1999). New Directions in Teaching Chemistry: A Philosophical and Pedagogical Basis. *J Chem Educ,* 76, 566-569.

Spencer, J.N. (2000). New directions in general chemistry: How recent research is changing the introductory Chemistry course. In W.B. Bond (Ed.), *Teacher's Guide: AP Chemistry* (pp. 1-9). New York: College Board Publications.

Spencer, J.N. (2006). New approaches to chemistry teaching. *J Chem Educ*, 83, 528-535.

Spencer, J.N., & Moog, R.S. (2008). The process oriented guided inquiry learning approach to teaching physical chemistry. In M.D. Ellison & T.A. Schoolcraft (Eds.), *Advances in Teaching Physical Chemistry: ACS Symposium Series* 973 (pp. 268-279). Washington, D.C.: American Chemical Society.

Stegall, S.L., Grushow, A., Whitnell, R. & Hunnicutt, S. (2016). Evaluating the effectiveness of POGIL-PCL workshops. *Chem Educ Res Pract*.

Straumanis A. and Simons E. (2006). Assessment of student learning in POGIL organic chemistry. *Abstr Pap Am Chem Soc*, 26 Mar 2006, Vol. 231. Meeting abstract: 1272-CHED.

Vacek, J. (2011). Process oriented guided inquiry learning (POGIL), a teaching method from physical sciences, promotes deep student learning in Aviation. *Collegiate Aviat Rev*, 29(2), 78-88.

Walker, L., and Warfa, A.M. (2017). Process oriented guided inquiry learning (POGIL) marginally effects achievement measures but substantially increases the odds of passing a course. *PLoS ONE* 12(10): e0186203.

Zawadzki, R. (2010). Is process-oriented guided-inquiry learning (POGIL) suitable as a teaching method in Thailand's higher education? *Asian J Educ Learn*, 1(2), 66-74.

Zullo, A. (2017). Guiding chemistry students with essential questions. *Educator's Voice*, X, 1-10. doi:https://www.nysut.org/~/media/files/nysut/resources/2017/edvoice/edvoice_x_09_chemistry.pdf?la=en

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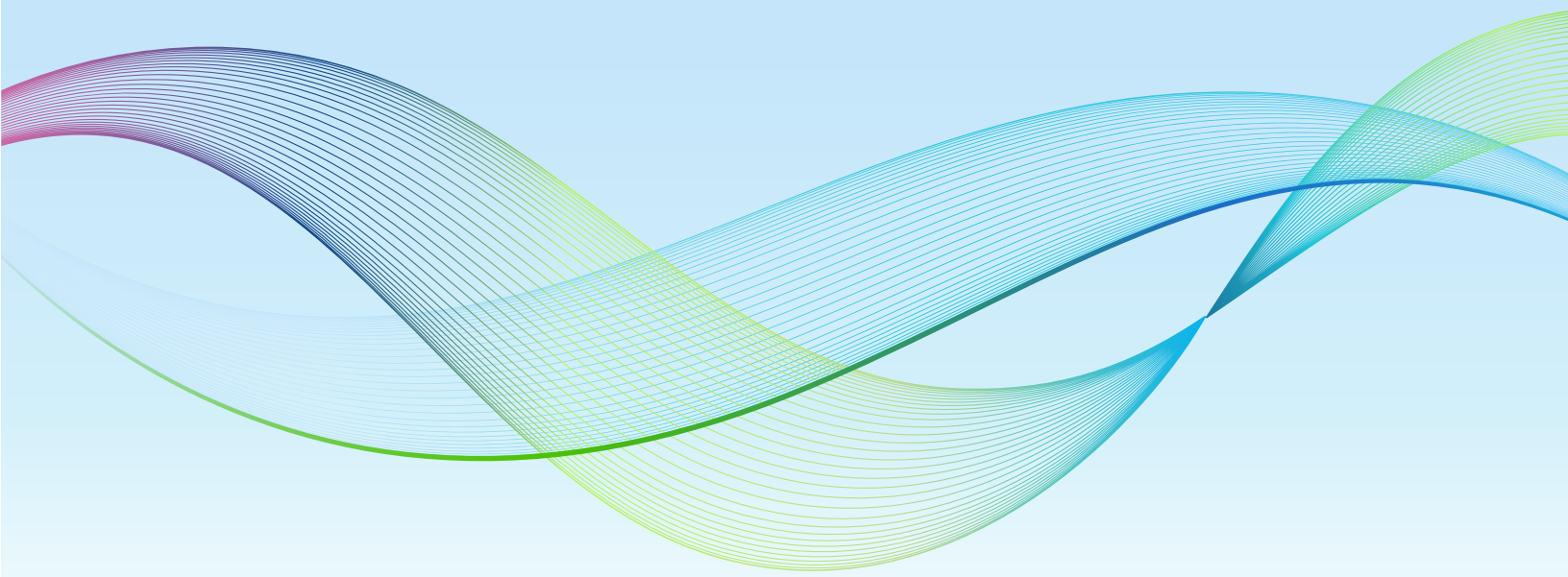

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