2019

Assessment, Evaluation, Metacognition, and Grading in POGIL

Shawn R. Simonson
Boise State University, shawnsimonson@boisestate.edu

Publication Information

Simonson, Shawn R.. (2019). "Assessment, Evaluation, Metacognition, and Grading in POGIL". *POGIL: An Introduction to Process Oriented Guided Inquiry Learning for Those Who Wish to Empower Learners,* 215-230.

10

ASSESSMENT, EVALUATION, METACOGNITION, AND GRADING IN POGIL

Shawn R. Simonson

I truly believe no matter the level of student, all students can participate and learn in this form. Set your expectations that all students can learn this way and don't underestimate them. By doing POGIL you can actually see your students learning and it is wonderful!

—A POGIL practitioner

How does POGIL fit into grading schemes for assignments, tests, and the course? POGIL activities are not designed to be graded as assessments; rather, they are intended as learning tools. However, one of the principle process skills targeted by POGIL is assessment—specifically self-assessment. Thus, much of the grading and assessment in a POGIL classroom helps students learn how to self-assess (metacognition) and, in turn, self-regulate. The instructor must model how to self-assess and emphasize its importance. Assessment is also more meaningful when it occurs in proximity to the learning. Common tools to accomplish this are enhancing metacognition, creating individual and group accountability via grading group work and peer grading, and frequent formative assessments.

Simply attending class improves quiz and test performance; however, instructors generally want students to not only do well on tests but also later recall and use the content (Shimoff & Catania, 2001). Active learning increases the number of cues that students have to aid information retrieval and helps them learn and/or retain content and concepts (Bransford et al., 2000; Credé, Roch, & Kieszczynka, 2010; Deci, Vallerand, Pelletier, & Ryan, 1991; Doyle, 2008; Karpicke & Roediger, 2008; McDaniel, Roediger, &

McDermott, 2007; Medina, 2008; M.D. Miller, 2011). Using assessments to require repeated retrieval and use of course content is more effective for improving retention than simple repetition (Karpicke & Roediger, 2008; McDaniel et al., 2007). Timely feedback, or correction of knowledge, also aids retention and later performance by aiding metacognition, the understanding of what is known and not known (McDaniel et al., 2007; Thomas & McDaniel, 2007).

Assessment improves retention by focusing the learner's attention on pertinent content and concepts, consolidating learning, and providing practice (Crooks, 2001; Karpicke & Roediger, 2008; McDaniel et al., 2007). However, according to Crooks (2001), it offers other effects: (a) It guides subsequent and/or additional instruction; (b) it influences motivation and self-efficacy; (c) it communicates, reinforces (or undermines) performance criteria and standards; (d) it modulates students' development of learning strategies; and (e) it influences students' decisions about what to (dis)continue to study and pursue as a career. Given these significant effects and the potential for negative outcomes, it is imperative that assessment be appropriate and provide accurate and meaningful results.

If a teacher is lecturing and the students are memorizing, then a standardized multiple-choice test may be the appropriate assessment tool (Gulikers, Bastiaens, & Kirschner, 2004). However, if the educational goal is that students grow as learners, develop the ability to build their own knowledge, and become reflective practitioners, then perhaps the multiple-choice test is not the only tool that should be used, and alternative assessments should be incorporated. Alternative assessments require students be responsible for their learning and for reflecting and collaborating with other students and the facilitator (Gulikers et al., 2004). Multiple assessment formats are used and are built around interesting and real-world problems (Gulikers et al., 2004).

Definitions

Assessment is one of those areas in which several terms are used interchangeably, so it is beneficial to clarify the discussion with agreed-on definitions:

> *Assessment*: As stated in chapter 3, assessment is an activity designed to improve future performance. It is any activity that provides evidence of what the students and teacher are doing; how the students are changing; and what the students are accomplishing, learning, and thinking (Crooks, 2001). Assessment can be of the activity, the learning, and the teaching as it is performed by both the teacher and the students.

Formative assessment, also referred to as assessment *for* learning, is the collection of instantaneous, often informal, data about student learning to support learners and help instructors make improvements in teaching and learning (Angelo & Cross, 1993; Crooks, 2001; Education Reform, 2014; Taras, 2010). In this chapter, the term *assessment* will refer to formative assessment.

Evaluation for our purposes is synonymous with summative assessment and is also referred to as assessment *of* learning. It is the analysis of data and comparison to standards to judge performance and determine passing or failing, and it is the assigning of grades to determine what students have learned as well as allowing appraisal of the course, teacher, and program performance (Angelo & Cross, 1993; Crooks, 2001; Education Reform, 2013). In this chapter, the term *evaluation* will refer to summative assessment.

Grading is the process of applying standardized measurements of varying levels of achievement in a course. Grading is not just giving students a rubric or answer key to assign a score. Grading and self-assessment are used as a technique to allow students to realize and identify what they do or do not know and how they must transform their learning to acquire the skills or knowledge necessary to learn and master the content.

Self-assessment is the process of individuals gathering evidence about their own abilities and performance and reflecting on that information with the intent to improve subsequent performance (Baird, 1986). It is critical to metacognition.

Metacognition entails awareness of one's own understanding of what one knows and does not know. It requires reflection and performance monitoring (self-assessment); being aware of one's personal abilities, knowledge, and learning; and planning for learning (McDaniel et al., 2007; Schraw, 1998; Thomas & McDaniel, 2007; Tobias & Everson, 2009).

Assessment, Evaluation, and Grading

Assessment for learning is a process that most instructors do reflexively. We often "take the temperature" of a class or contemplate how well the students are grasping the material. Formative assessment can "supplement and complement" evaluations (Angelo & Cross, 1993, p. 26). Making this process intentional and transparent, as well as mapping it to course outcomes and student performance, can enhance both teaching and learning.

A few specific techniques commonly used in POGIL classrooms will be discussed here. Others can be found in chapter 6. Angelo and Cross's (1993) *Classroom Assessment Techniques: A Handbook for College Teachers*, and the

newer companion book by Barkley and Major (2016a), *Learning Assessment Techniques: A Handbook for College Faculty*, present many more excellent suggestions that are applicable at any grade level.

Facilitators should determine the key concepts in an activity based on the course and lesson learning objectives and the activity itself. Facilitation guides, provided with most published POGIL activities, indicate what the activity author suggests as the key concepts. In addition, some POGIL activities, particularly for high school, are designed with the key concepts indicated by a symbol in the activity—often a picture of a key. It is only these questions that facilitators need to verify as correct in some way. If students can answer these key questions correctly, then the preceding answers were also correct. This verification can occur via various modes of student reporting or of the instructor asking a similar question that requires the students to have successfully completed the preceding portion of an activity. For example, in the economics activity *Credit Default Swap*, used in the introductory POGIL workshop, participants are asked to determine how much money the pension fund would earn under conditions not previously described in the activity model. If participants understand the model, they will correctly answer this novel question.

Application questions that require students to use their freshly constructed knowledge in new ways or unique combinations are often included at the end of POGIL activities. Solving a real-world problem by using the newly acquired content provides an opportunity to assess student understanding and higher-order thinking, enhances understanding, and provides an opportunity to help students develop thinking patterns similar to experts' (Gulikers et al., 2004). Real-world tasks beyond the POGIL activity can also enhance student motivation and help them identify future opportunities to use the content and skills developed (Fink, 2003). These tasks should be scaled to student ability and kept as similar to what professionals in the field routinely wrestle with as possible. For example, a series of earth science units over geology, watersheds, and pollution might end with student teams deciding where to place another sewage treatment plant in their local community. Solving real-world problems can also be used to model and foster self-assessment and regulation, and these two skills will be discussed more completely later in the metacognition discussion.

Many teachers will agree that most students are not going to work as hard, or even complete an assignment, unless there is a grade attached. This pay-for-play attitude can be improved in the POGIL classroom, but it requires scaffolding—and that scaffolding can be via providing points for student work on the POGIL activities. A common first-level activity point-awarding mechanism involves simply giving students credit for completing the activity. This can be ramped up and foster team and individual accountability by

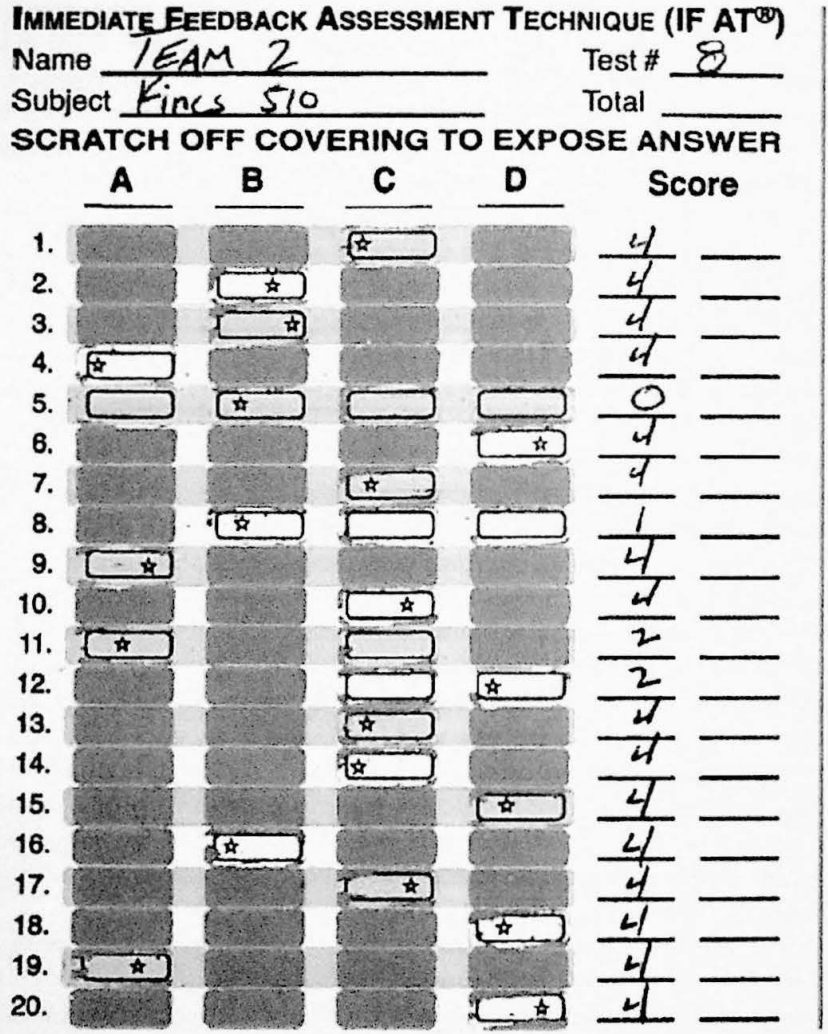
moving to randomly collecting and reviewing a single student's paper from the team and assuming the whole team has the same level of understanding—and assigning all team members the same points. Another version of this is to ask each team spokesperson to collect all the previous day's activities. Then, the spokesperson turns each copy to a specific question as directed by the facilitator. If all the team members' answers are the same, everyone in the team earns full points for reaching and recording a consensus answer. If even one member's answer differs, all team members receive zero credit. A third level of this scaffolding is to then move to the recorder's report, turned in at the end of each class, as a log of the important concept that the team has learned. The final scaffold level is then no collection of evidence that students have completed the activity.

Numerous POGIL facilitators start each class session with a short quiz based on the content mastered in the previous class. Depending on how the results of these quizzes are used, these can be assessments or evaluations. They serve to identify misconceptions and/or gaps in understanding and to provide encouragement for the students to continue to work with the material outside of class. Unit tests are another obvious evaluation/grading opportunity. Taking the quizzes and tests a step further to encourage both individual and team accountability is the two-stage test used in some POGIL and other collaborative learning classrooms. In the first stage, students take the test individually. This can be turned in or kept for reference, based on the instructor's preference. In the second stage, students retake the test in their teams. Scores on the two tests can be recorded separately, averaged, or weighted per the instructor's preference (in some of my courses, at the beginning of the semester, the students determine how these scores will be weighted) (Michaelsen, Knight, & Fink, 2004; Nowak, Miller, & Washburn, 1996).

For multiple-choice tests, instructors can use Immediate Feedback Assessment Technique (IF-AT) forms (Epstein, n.d.). (An Internet search for "how to make scratch-off cards" also nets several do-it-yourself methods for making cards.) These tests not only save time by having the students grade their tests and identify the correct answers as they complete them but also correct errors in thought. IF-AT forms are preprinted scratch-off test forms that indicate the correct answer as students are taking the test. Students score higher when they make fewer scratches to find the correct answer. See Figure 10.1 for an example. Cognalearn (intedashboard.com) has an online version of this testing format as well.

There are also evaluation methods that simultaneously encourage metacognition. Two examples of this are weighting confidence and accuracy credit. Weighting confidence can be performed in multiple ways. One, used

Figure 10.1. Sample IF-AT form.



Note. Answers are weighted: 1 scratch = 4 points, 2 scratches = 2 points, 3 scratches = 1 point.

on multiple-choice tests, is to assign each question a value of four points. Students can then distribute those points across the four answer options as they see fit: four points on an answer option if they are very confident that they are correct, two and two on two answer options if they are split, three and one, or even ones across all of the answer options if they have no idea. They then earn the points assigned to the correct answer (Michaelsen et al., 2004). Another confidence-weighting method is to have students rate their

short or longer answers by how confident they are in their correctness from very confident that the answer is correct to very confident that the answer is incorrect. Accurate confidence ratings are used as a multiplier of the problem scores to generate a test score that encourages student contemplation of confidence (Petr, 2001). Another method for providing encouragement to develop and demonstrate problem-solving skills is awarding credit for accuracy. This is the traditional approach of giving students (partial) credit for correctly setting up and solving problems.

Metacognition

Monitoring knowledge is the foundation of metacognition and the higher-level metacognitive skills: Selecting strategies, evaluating learning, planning, and controlling require *accurate* knowledge monitoring (Serra & Metcalfe, 2009; Tobias & Everson, 2009). However, metacognition does not come naturally to most learners, and it is not routinely promoted in education (Winne & Nesbit, 2009). Yet, improving metacognition is possible and requires that students take responsibility for their learning and intentionally practice metacognitive and decision-making skills (Baird, 1986; Baird & White, 1982). Additionally, minimally related to IQ, metacognitive skills are transferable. They are *not* content specific and, once learned, can be applied in a variety of situations (Schraw, 1998).

First, to promote metacognition, learners must be aware of metacognition—that it is different from content knowledge and understanding and that it will enhance success (Schraw, 1998). Second, learners must believe that they can be self-regulated learners and that they do have control (Dweck & Leggett, 1988; Winne & Nesbit, 2009). Third, strategies to encourage and enhance metacognition must be presented and practiced (Baird, 1986; Schraw, 1998). Learning and using metacognition is like learning any other concept or skill—scaffolding and multiple approaches enhance uptake and internalization (Baird & White, 1982). Direct instruction, modeled by both the instructor and other students; reflection; and group activities all fit into the scaffold (Baird, 1986; Schraw, 1998). Creating a classroom that helps students identify improvement, encourages mastery and increased effort, and rewards persistence also enhances metacognitive development (Schraw, 1998). Fourth, making mistakes may have been discouraged in earlier learning environments, and students may have learned to avoid and/or be demotivated by them. Thus, they need to develop the appreciation that mistakes are learning opportunities to be taken advantage of (Winne & Nesbit, 2009).

The beginning of class or an activity is an excellent opportunity to enhance metacognition by explicitly activating prior learning or knowledge.

In 1987, the Biological Sciences Curriculum Study (BSCS) elaborated on the Atkins and Karplus three-phase learning cycle, on which POGIL is based, to add two phases: engagement in the beginning and evaluation at the end (Bybee et al., 2006). Engaging students before starting a new activity by piquing their curiosity and helping them identify what they already know about a topic improves metacognition *and* understanding, can be accomplished in numerous ways, and is limited only by the facilitator's imagination and skill set (Baird, 1986; K.A. Miller, Lasry, Chu, & Mazur, 2013; Tanner, 2010). See Table 10.1 for suggestions.

Misconceptions can be very persistent and may require significant energy and repeated efforts to correct (Baird & White, 1982). Inquiry learning, such as POGIL, is an important method for helping students identify and shift from their current knowledge and misunderstandings to the concepts and theories held by content experts (Tanner & Allen, 2005). Inquiry-based learning encourages students to think and ask questions in the habits of mind used by scholars: to challenge preconceptions and current models in an effort to advance new and better ideas (Tanner & Allen, 2005). Thus, it is a significant opportunity when selecting or writing POGIL activities to include models that address and challenge common misconceptions. It can also be beneficial to call out this concept transition so that students are aware that it occurred.

The end of a class or an activity is another chance to develop metacognition by asking students to assess their learning. An obvious tool is to include metacognition opportunities or questions at the end of the POGIL activity. During this additional evaluation phase of the learning cycle, students reflect on their learning and reveal their skill or content proficiency, thus providing the instructor the opportunity to assess students' progress (Bybee et al., 2006). The evaluation phase can take on many forms and is limited only by the instructor's imagination and repertoire (Baird, 1986; Davis, 1993; Isaacson & Was, 2010; Schraw, 1998; Tanner, 2010). See Table 10.1 for suggestions.

Postactivity knowledge reflections and content organizers seem to be more effective if there is a time delay between activity completion and the implementation of these tools. The delay forces use of long-term memory rather than working memory (Serra & Metcalfe, 2009). Daily quizzes at the start of class work well to provide an appropriate time delay and improve content retention (Karpicke & Roediger, 2008; McDaniel et al., 2007).

Observing others engaged in metacognition helps students develop their own metacognitive skills. This observation can be of the instructor, other students, and themselves. Teachers should explicitly model their own metacognition by calling out their problem-solving, decision-making, and regulatory techniques (Butler & Winne, 1995).

TABLE 10.1
Sample Methods for Engaging and Assessing Students

Engaging prior to learning
Use a preliminary or the initial model to engender curiosity in the POGIL activity.
Ask students to predict the outcome of a demonstration and then respond to the results of that demonstration (K.A. Miller et al., 2013).
Ask students to explain their prior knowledge about the content of the subject.
Assign prereadings from the popular press or Internet.
Give preassessment questions.
Use discrepant events (unexpected examples) of a phenomenon.
Establish process goals to be targeted during the activity.
Assessing after learning
Give application questions at the end of the POGIL activity.
Have students/teams complete a minute paper to identify muddiest points (questions) and most important concepts. This encourages learners to reflect on the state of their knowledge prior to leaving the class (Angelo & Cross, 1993; Davis, 1993).
Give quizzes and tests, in or out of class. Asking students to rate their confidence in their answers on daily quizzes—and compounding points when confidence matches correctness—further enhances metacognition (Isaacson & Was, 2010).
Ask for knowledge reflection in which the students are asked to summarize and share the key concepts learned in the activity.
Use content organizers that demonstrate relationships (i.e., concept maps or flow charts, poster presentations, pamphlets, papers).
Ask students what they learned or what contradicted their prior knowledge.
Predict the outcome of another demonstration.
Encourage students to reflect on their learning and share these reflections with other students.

Note. Baird,1986; Isaacson & Was, 2010; Schraw, 1998; Tanner, 2010.

This can start with the instructor determining what abilities and tools are critical within their content area and recalling how they developed these abilities (Schraw, 1998). Teachers can explicitly describe these skills as they are using them. For example, when demonstrating problem-solving, do not simply demonstrate the steps, share the thought processes that you are going through to make choices and move from one step to the next

(Schraw, 1998). Working in groups can aid metacognition as peer observation may be as good as or better than observing the instructor. Students often closely observe their classmates and feel that mimicking their peers is more possible, reasonable, likely, and comfortable than mimicking the instructor (Schraw, 1998).

Self-observation and reflection are critical in developing and improving metacognitive skills (Schraw, 1998). There are a variety of reflection prompts that can be used here. Asking students to reflect on their exam performance, study habits, and preparation effectiveness helps students explore the success of their preparation strategies and make plans to improve them. "What, so what, now what" journals help students frame their learning process. They identify what happened and how it was different from what they already knew. Next, students identify why what they learned matters and how it aligns with what they have learned elsewhere. Last, they plan for how they will use what they learned, what they will share with others, and what they want to learn next (Barkley & Major, 2016b). Mary Jarratt Smith (2016) at Boise State University provides her differential equation students with metacognition cards, printed on card stock, that detail steps and/or questions they can use when solving problems. Mare Sullivan, now at Seattle Pacific University, used a similar KNAP SACK strategy with her junior and senior high students. Shown in Figure 10.2, supports like these can be used in a variety of settings. Students can also be encouraged to contemplate what has worked well and what has not. In addition, helping students identify their strengths, opportunities for improvement, time-management tendencies, and study strategies are just a few examples of metacognitive strategies.

Promoting Teamwork: Team and Peer Assessment

As indicated in chapter 6, a component of helping students value group work is assessing and/or evaluating the group work. This can be done by the facilitator and/or by the students themselves. Some POGIL facilitators use participation grades for each team's work, while others assign content grades. Individual activities can be collected to indicate that all students are responsible for their own learning. Or, as mentioned previously, one copy of the activity can be collected from each team: one team member's activity randomly reviewed and a team grade assigned based on that individual's response, operating on the assumption that the team has worked together, that thay have come to a consensus, and that they all have completed the activity. Some facilitators may collect completed activities and assign a content grade to individuals or whole teams.

Figure 10.2. Sample strategies for aiding student problem-solving and prompting metacognition.

Metacognition card
1. Reflect before solving • What is the problem asking me to do? • What concept is the problem asking me to use? • How is this problem similar to ones that I have done before? How is it different? • What strategies can I use to solve the problem?
2. Monitor during solving • Am I on the right track? • Do I need a new plan or strategy? • Am I closer to my goal? • How should I proceed?
3. Evaluate after solving • Did I get the results I expected? • What worked? What didn't work? • What could I have done differently? • Do I need to go back and fill in gaps in my understanding?

Always bring your KNAP SACK with you	
K	Write down everything that you already KNOW that might help you.
N	Identify what you NEED to know. How will you know when you have arrived at the answer?
A	Describe how you will ATTACK the problem. What steps will you take? What subproblems will you solve?
P	PREDICT your answer. What do you expect, based on logical thinking? A huge number? A tiny number? A number near one? What units should the answer be in?
S	SOLVE the problem.
A	AND
C	CHECK your answer against your prediction.
K	KISS the problem good-bye and move on!

Individual and team accountability can be encouraged by assessing, evaluating, and grading teamwork and team contributions. Peer grading should be included at some level in all collaborative learning environments, and there are myriad tools available. Initially, students may not assess their peers with much enthusiasm or accuracy. One of the most common student complaints

about group work is the uneven distribution of effort. Remind students that assessing their peers is their opportunity to encourage positive change by calling attention to loafing as well as exceptional effort. Again, transparency and scaffolding are beneficial. If the instructor communicates to the students that their input is important and will be seriously considered, students are more likely to put effort and thought into peer assessments and evaluation. This is also a situation where maintaining the same teams and using roles for a period of time is beneficial, as students are more likely to honestly review their peers when they have observed their performance over a longer period.

What to do with the peer assessments and evaluations? In my classes, I have a separate grade category dedicated to team contribution. Somewhere from 10% to 15% of a student's grade is determined by their peers. Another method of using peer grading is to use it as a multiplier for grades on teamwork. This awards the highest grades to the students whom peers identify as making the most significant contribution the team.

Scaffolding peer assessment and evaluation is necessary to help students develop confidence and skill. Familiar to POGIL practitioners, initially an SII of the team and its members can be used: *S* asks for strengths and why they are strengths, the first *I* asks for opportunities for improvement and how those improvements might be made, and the second *I* asks for insights about the team/individual. Students may initially earn completion credit for this peer assessment, with anonymous feedback provided to the assessed team members. A next level can be ranking students from most to least valuable contributors. An averaged distribution is then shared with the team members. This assessment strategy decouples the peer review from grades, making it informative without grade pressure. A following step is to ask students to assign a percentage of effectiveness score to each team member. A rationale for each score is required. Evaluated team members then receive an average of their assigned scores and anonymous feedback. The final level can then be asking team members to grade each other without assigning the same grade to any of their teammates and requiring that the overall score average to a set standard (Michaelsen et al., 2004).

While some do not care for rubrics because of their rigidity and inherent imperfection, rubrics can be helpful in teaching students to assess and evaluate each other's contribution to the team. The Association of American Colleges & Universities (AAC&U) has several excellent VALUE rubrics—one of which is for teamwork (AAC&U, n.d.). Karen Franker at the University of Wisconsin, Stout has rubrics available for assessing teamwork at the primary through high school levels (University of Wisconsin, Stout, n.d.). Suzanne Ruder (2014) at Virginia Commonwealth University has a series of short rubrics that encourage

students to rate each other on the POGIL targeted areas of critical thinking, information processing, problem-solving, and teamwork. Ruder's rubrics eventually led to the ELIPSS project and the newer, modified rubrics being developed by that team (see chapter 3 for more information).

High-stakes assessments, such as exams, can also be used to support the importance of effective teamwork by rooting exam questions in the type of thinking required by POGIL activities. As such, there should be exam questions that go beyond rote learning to include application, analysis, and other high-level cognitive skills. The POGIL approach effectively includes all six of Fink's (2003) taxonomic categories of foundational knowledge, application, integration, learning how to learn, caring, and human dimension, many of which can be incorporated into well-designed assessments. Thus, even the grading of content skills can be used to emphasize and reward effective work in POGIL teams.

It was toward the end of the semester in my undergraduate exercise physiology course and we were finally learning about metabolic pathways and the contribution of each to physical activity. (Most exercise physiology courses start there, but I prefer to end there as it is some of the least familiar content. I like to start with muscle, something that most kinesiology students have some prior knowledge about and are somewhat interested in.) The students were in their teams working on the POGIL activity Metabolism: Cellular Respiration: Part 2 in which the reasons and pathways for lactic acid production and clearance are discovered. As the activity was winding down, a student called me over and asked for clarification about how lactate formation and clearance related to cardiopulmonary function and acid/base regulation. I answered that she was on the right track. She then took it several steps further and tied it all to muscle contraction, fiber typing, and the energy demands of physical activity.

I could not contain my enthusiasm as I responded, "Exactly!"

Her response to my "exactly" was to jump up out of her seat, throw her arms (and her activity) up in the air, and shout, "I get it!" The whole class came to a grinding halt and she proudly repeated her description of how energy for muscle contraction, fiber types, acid/base regulation, and the metabolic pathways all tied together.

Her peers applauded!

—Shawn R. Simonson,
Professor, Boise State University

Summary

- Frequent assessment and evaluations, individual and group accountability, and peer grading enhance learning and retention.
- Self-assessment is one of the principle process skills targeted by POGIL.
- Grading and assessment in a POGIL classroom are designed to help students learn how to self-assess and self-regulate.
- Scaffolding and modeling of self-assessment emphasizes its importance and promotes its development.
- Metacognition is a skill that requires intentional practice.

Listening to my students while they work on POGIL activities is the single greatest insight into how they think and learn! Don't miss a chance to hear them talking, thinking, etc. It is gold.

—A POGIL practitioner of eight years

References

Angelo, T. A., & Cross, K. P. (1993). *Classroom assessment techniques: A handbook for college teachers* (2nd ed.). San Francisco, CA: Jossey-Bass.

Association of American Colleges & Universities. (n.d.). *Teamwork VALUE rubric.* Retrieved from https://www.aacu.org/value/rubrics/teamwork

Baird, J. R. (1986). Improving learning through enhanced metacognition: A classroom study. *European Journal of Science Education, 8*(3), 263–282.

Baird, J. R., & White, R. T. (1982). Promoting self-control of learning. *Instructional Science, 11*(3), 227–247.

Barkley, E. F., & Major, C. H. (2016a). *Learning assessment techniques: A handbook for college faculty.* San Francisco, CA: Jossey-Bass.

Barkley, E. F., & Major, C. H. (2016b). What? So what? Now what? journals. In E. F. Barkley & C. H. Major (Eds.), *Learning assessment techniques: A handbook for college faculty* (pp. 388–392). San Francisco, CA: Jossey-Bass.

Bransford, J. D., Brown, A. L., Cocking, R. R., Donovan, M. S., Bransford, J. D., & Pellegrino, J. W. (Eds.). (2000). *How people learn: Brain, mind, experience, and school: Expanded edition.* Washington, DC: National Academies Press.

Butler, D. L., & Winne, P. H. (1995). Feedback and self-regulated learning: A theoretical synthesis. *Review of Educational Research, 65*(3), 245–281.

Bybee, R. W., Taylor, J. A., Gardner, A., Van Scotter, P., Carlson Powell, J., Westbrook, A., & Landes, N. (2006). *BSCS 5E instructional model: Origins and effectiveness.* Retrieved from https://bscs.org/bscs-5e-instructional-model

Credé, M., Roch, S. G., & Kieszczynka, U. M. (2010). Class attendance in college: A meta-analytic review of the relationship of class attendance with grades and student characteristics. *Review of Educational Research, 80*(2), 272–295.

Crooks, T. (2001). *The validity of formative assessments.* Paper presented at the British Educational Research Association Annual Conference, University of Leeds, Leeds, UK. Retrieved from http://www.leeds.ac.uk/educol/documents/00001862.htm

Davis, B. G. (1993). *Tools for teaching.* San Francisco, CA: Jossey-Bass.

Deci, E. L., Vallerand, R. J., Pelletier, L. G., & Ryan, R. M. (1991). Motivation and education: The self-determination perspective. *Educational Psychologist, 26*(3–4), 325–346.

Doyle, T. (2008). *Helping students learn in a learner-centered environment.* Sterling, VA: Stylus.

Dweck, C. S., & Leggett, E. L. (1988). A social-cognitive approach to motivation and personality. *Psychological Review, 95*(2), 256–273.

Education Reform. (2014, April 29). *Formative assessment.* Retrieved from http://edglossary.org/formative-assessment/

Education Reform. (2013, August 29). *Summative assessment.* Retrieved from http://edglossary.org/summative-assessment/

Epstein. (n.d.). *What is the IF-AT?* Retrieved from http://www.epsteineducation.com/home/about

Fink, L. D. (2003). *Creating significant learning experiences: An integrated approach to designing college courses.* San Francisco, CA: Jossey-Bass.

Gulikers, J. T. M., Bastiaens, T. J., & Kirschner, P. A. (2004). A five-dimensional framework for authentic assessment. *Educational Technology Research and Development, 52*(3), 67–86.

Isaacson, R. M., & Was, C. A. (2010). Building a metacognitive curriculum: An educational psychology to teach metacognition. *National Teaching and Learning Forum, 19*(5), 1–4.

Jarratt Smith, M. (2016). *Training students to be better critical thinkers.* Paper presented at the Colloquim, Augustana University, Sioux Falls, SD.

Karpicke, J. D., & Roediger, H. L., III. (2008). The critical importance of retrieval for learning. *Science, 319*(5865), 966–968.

McDaniel, M. A., Roediger, H. L., III, & McDermott, K. B. (2007). Generalizing test-enhanced learning from the laboratory to the classroom. *Psychonomic Bulletin and Review, 14*(2), 200–206.

Medina, J. (2008). *Brain rules: 12 principles for surviving and thriving at work, home, and school.* Seattle, WA: Pear Press.

Michaelsen, L. K., Knight, A. B., & Fink, L. D. (2004). *Team-based learning: A transformative use of small groups in college teaching.* Sterling, VA: Stylus.

Miller, K. A., Lasry, N., Chu, K., & Mazur, E. (2013). Role of physics lecture demonstrations in conceptual learning. *Physics Education Research, 9*(020113), 1–5.

Miller, M. D. (2011). What college teachers should know about memory: A perspective from cognitive psychology. *College Teaching, 59*(3), 117–122.

Nowak, L. I., Miller, S. W., & Washburn, J. H. (1996). Team testing increases performance. *Journal of Education for Business, 71*(5), 253–256.

Petr, D. W. (2001). Confidence scores measure (and enhance?) student perceptions of their work. *Journal of Engineering Education, 90*(4), 469–475.

Ruder, S. M. (2014). *Assessing process skills in a large POGIL classroom.* Paper presented at the Biennial Conference on Chemical Education, Grand Valley State University, Allendale, MI.

Schraw, G. (1998). Promoting general metacognitive awareness. *Instructional Science, 26*(1–2), 113–125.

Serra, M. J., & Metcalfe, J. (2009). Effective implementation of metacognition. In D. J. Hacker, J. Dunlosky, & A. C. Graesser (Eds.), *Handbook of metacognition in education* (pp. 278–298). New York, NY: Routledge.

Shimoff, E., & Catania, A. C. (2001). Effects of recording attendance on grades in introductory psychology. *Teaching of Psychology, 28*(3), 192–195.

Tanner, K. D. (2010). Order matters: Using the 5E model to align teaching with how people learn. *Life Sciences Education, 9*(3), 159–164.

Tanner, K. D., & Allen, D. (2005, Summer). Approaches to biology teaching and learning: Understanding the wrong answers—teaching toward conceptual change. *Cell Biology Education, 4*(2), 112–117.

Taras, M. (2010). Assessment for learning: Assessing the theory and evidence. *Procedia—Social and Behavioral Sciences, 2*(2), 3015–3022.

Thomas, A. K., & McDaniel, M. A. (2007). Metacomprehension for educationally relevant materials: Dramatic effects of encoding-retrieval interactions. *Psychonomic Bulletin and Review, 14*(2), 212–218.

Tobias, S., & Everson, H. T. (2009). The importance of knowing what you know. In D. J. Hacker, J. Dunlosky, & A. C. Graesser (Eds.), *Handbook of metacognition in education* (pp. 107–128). New York, NY: Routledge.

University of Wisconsin, (n.d.). *Examples of rubrics.* Retrieved from https://www.uwstout.edu/soe/profdev/rubrics.cfm#cooperative

Winne, P. H., & Nesbit, J. C. (2009). Supporting self-regulated learning with cognitive tools. In D. J. Hacker, J. Dunlosky, & A. C. Graesser (Eds.), *Handbook of metacognition in education* (pp. 259–277). New York, NY: Routledge.