POGIL Beyond STEM

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This chapter focuses on POGIL’s extension and application in non-science, technology, engineering, and mathematics (STEM) disciplines, building on the foundations of POGIL previously discussed in this book. The theory, process, guided inquiry, and evidence of student success are applicable to non-STEM disciplines; however, each discipline may require a few adjustments in content and delivery. Many non-STEM disciplines rely heavily on process skills, which are paramount to the POGIL process. Details on applications to the fields of second language (L2) learning and information literacy serve as case studies, with evidence of learning enhancement and similar foundational learning theories.

Literature Review

POGIL has been used in a wide variety of non-STEM disciplines such as marketing (Hale & Mullen, 2009), German language (Johnson, Cagle, & Jackson, 2011), financial literacy (Maurer, 2014), information literacy (Loo, 2013; Mitchell & Hiatt, 2010; Moore, Black, Glackin, Ruppel, & Watson, 2015), aviation (Vacek, 2011), programming (Hu & Shepherd, 2013), entrepreneurship (Kussmaul, 2011), urban education (Tobin, Ali-Khan, & Shady, 2014), and family science (Maurer, 2012). Four studies in this group stand out because they were conducted in the fields of L2 learning (Johnson et al., 2011) and information literacy (Loo, 2013; Mitchell & Hiatt, 2010; Moore et al., 2015), the topics of this chapter’s case studies. Johnson and colleagues (2011) recommends using POGIL lessons to encourage learners to develop
their own explanations for complicated grammar rules in L2 acquisition. The group inquiry work in Johnson's German class developed critical thinking skills by working “through language-related frustrations and insecurities,” gaining confidence in learning “on their own” (Johnson et al., 2011, p. 31), self-correcting mistakes, and working well as part of a team.

Mitchell and Hiatt (2010) presented a case study using the POGIL method in a credit-bearing information literacy course that consisted of three lesson plans: research topic identification and exploration, topic outline and resource identification, and resource evaluation. After the information literacy POGIL unit concluded, students indicated that the “active nature of learning these concepts and skills was preferable to other methods” (Mitchell & Hiatt, 2010, p. 541).

Loo (2013) discussed improving learning of information literacy skills in one session of a chemistry class with guided and team-based activities that incorporated process worksheets and POGIL elements. “Students gained practical hands-on experience in a guided fashion,” with the librarian providing personalized learning support and observing student progress during class (Loo, 2013, pp. 258–259).

Moore and colleagues (2015), in their descriptive study of information literacy instruction based on POGIL, concluded, “The information literacy instruction, linking learning activities directly to student assignments, was advantageous to skill mastery, retention, and transference” (p. 162). In addition, incorporating POGIL increased student engagement and provided students experience in critical thinking, problem-solving, and teamwork.

While it is interesting to learn about various ways POGIL has been incorporated into non-STEM disciplines, it is more valuable to discuss why going beyond STEM should be considered.

Why Go Beyond STEM With POGIL?

Employing the POGIL method in any discipline provides the opportunity to impart transfer skills; teach process skills and social learning; improve mastery of content, skills, and depth of learning; increase course exam scores and grades and standardized test scores; increase student perceptions of the value of learning in teams; and lower course attrition rates. The fact that process skills help students transfer acquired procedural skills to new conceptual and social situations is the most valid reason to employ POGIL across disciplines. Active learning approaches target the universality of how things are learned (Bransford, Brown, & Cocking, 2000) with the intent of establishing the process for further learning. The struggle to impart transfer skills, or the ability to apply complex concepts to new situations, is continuous in every teaching field (Wiggins & McTighe, 2005). “Transfer is affected
by the degree to which people learn with understanding rather than merely memorize sets of facts or follow a fixed set of procedures” (Bransford et al., 2000, p. 55).

The processes in POGIL fit within two contemporary learning approaches that aim toward transfer in all disciplines: backward design, or the “flipped classroom” (Wiggins & McTighe, 2005), and entrepreneurial learning (Gibb & Price, 2014). Teachers begin with the important concepts to be grasped in a POGIL lesson, as they do in backward design. Subsequently, they design active learning procedures that can lead students to conceive big ideas. Guzdial (2015), a proponent of flipping the class, declares, “Be it resolved: Teaching statements must embrace active learning and eschew lecture.” His August 14, 2015, blog shows active learning to be more effective than lecturing. POGIL also fits within entrepreneurial learning, which uses terms from the business world to express the need for learner buy-in, investment, and willingness to take risks. “Group work is a major component of ensuring ownership of learning; ‘learning by doing,’ by inventing things, making things up, communicating orally, building teams, building confidence in a situation of low exposure and solving problems creatively” (Gibb & Price, 2014, p. 20).

Wiggins and McTighe (2005), in Understanding by Design, recommend creating essential questions that guide students and “stimulate thought, provoke inquiry, and spark more questions” (p. 107). Studies have shown that mastery of concepts and transfer skills occurs when the POGIL learning method is used (Hanson & Wolfskill, 2000; Lewis & Lewis, 2005; Straumanis & Simons, 2008). Mastery is possible because of POGIL’s basis in social constructivism (Becker, 2012) and use of the learning cycle in learning activities (see chapter 1). Additional studies have shown that using POGIL improves numerous content outcomes and student perceptions when compared to traditional teaching methods (see chapter 5).

In addition to this documented evidence, POGIL learning improves process skills such as teamwork, information processing, critical thinking, problem-solving, management, oral and written communication, and assessment. Per the POGIL (n.d.) website, “The process skills that we refer to here include both cognitive and affective processes that students use to ‘acquire, interpret, and apply knowledge.’” These process skills are in demand by employers and therefore should be included in any university discipline, in STEM disciplines, and beyond.

POGIL, therefore, can and should be used with any discipline at the middle school, secondary, and post-secondary levels. POGIL can be incorporated into any learning situation where learning for understanding is desired. However, some instructors experience difficulty seeing how the model-driven activities of STEM can apply to other content areas. The critical issue seems
to be the model on which to base the guided-inquiry questions. Here, it is useful to think like an expert in the field and ask, “What artifacts were used to develop the concepts of the field?” Thus, in literature the model may be comparing key passages of a work to find common or disparate themes; in government, analyzing quotes from the Constitution to identify critical principles; in linguistics, comparing verb conjugations to learn use and meaning; and in history, reading letters and associated period documents to discover cultural trends. The guiding questions then are based on the questions that an expert in the field might ask about the available artifacts. What follows are two examples of how this has been accomplished in French and information literacy.

**L2: A Case Study**

The POGIL method, though originally developed to teach chemistry, adapts well to foreign language acquisition. A strong approach is needed to master both disciplines, since verb charts and the periodic table create usable knowledge only when significant interactions take place. As Johnson and colleagues (2011) noted in the POGIL German course, “In contrast to rote memorization of charts, the POGIL method has the benefit of requiring that the students use the language to express ideas and content, even at the most basic levels” (p. 34). Stated another way, the target language is the process through which the language is learned. POGIL lessons can fulfill all five of the standards put forth by the American Council on the Teaching of Foreign Languages (ACTFL) because of this perpetual feedback loop.

**ACTFL Standards**

The ACTFL standards are often referred to as the five Cs because they are centered on communication, cultures, connections, comparisons, and communities. ACTFL targets L2 acquisition as “the powerful key to successful communication—how, when, and why to say what to whom” (ACTFL, 1996, p. 11). Table 12.1 relates the standards to POGIL actions.

**POGIL in L2 Learning**

Interactive modern language acquisition theories emerge from socio-constructive ideas formulated by Vygotskii (Vygotskii & Cole, 1978). According to Vygotskii, the child learns to speak through social interaction (Lightbown & Spada, 2008). Vygotskii calls the span between the child’s ability to perform a task alone and the progress made while interacting with an expert the zone of proximal development (ZPD) (Vygotskii & Cole,
### Table 12.1
The POGIL Response to the ACTFL Standards

<table>
<thead>
<tr>
<th>ACTFL Standards</th>
<th>ACTFL Goals</th>
<th>Realization within POGIL Lessons</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Communication</strong></td>
<td>To use the L2 to communicate. To be able to present information in several contexts</td>
<td>Use of the language to solve problems, follow directions, and present findings</td>
</tr>
<tr>
<td><strong>Cultures</strong></td>
<td>To appreciate the relationship between languages and other cultures. To become better able to understand other people's points of view, ways of life, and contributions to the world</td>
<td>Readings showing cultural ambiguity. Discussion of differing mental images across cultures (e.g., Does an informal and formal “you” change interpersonal relationships?)</td>
</tr>
<tr>
<td><strong>Connections</strong></td>
<td>To integrate content from other subject areas with world language instruction through lessons that are developed around common themes.</td>
<td>Reading L2 texts for meaning and structural analysis (e.g., a text about decolonization also contains the present tense forms of regular “it” verbs; grammar is in context)</td>
</tr>
<tr>
<td><strong>Comparisons</strong></td>
<td>To compare and contrast languages and cultures: discover patterns, make predictions, and analyze similarities and differences</td>
<td>Studying L1 and L2 differences (e.g., the French cannot “buy oranges.” They must divide them into parts: “j’achète des oranges” [of the oranges that exist in the world]. Does the partitive article cause French speakers to consume less?)</td>
</tr>
<tr>
<td><strong>Communities</strong></td>
<td>To extend learning experiences outside of the classroom in order to emphasize living in a global society</td>
<td>Finding an exchange class in an area where L2 is spoken. POGIL teams may write and decide which identity texts, travelogues, compositions, or fairy tales to share</td>
</tr>
</tbody>
</table>

*Note. For more information on ACTFL goals, visit the website at [www.globalteachinglearning.com/standards/5cs.shtml](http://www.globalteachinglearning.com/standards/5cs.shtml)*
1978). Per interactive theory, acquisition takes place through the vehicle of the language at the moment of interaction (Lightbown & Spada, 2008). For optimum interaction in L2 learning, Galisson (1980) recommends that discovery activities be realized in groups of four learners. In working together to discern solutions, POGIL teams become actors in their own learning (Tagliante, 2006), and the skill set of each member provides a ZPD for others.

This is what Swain (2000) calls collaborative dialogue in her theory of comprehensible output. According to Swain (2000), the interaction between input and output during the negotiation of meaning produces language acquisition. POGIL creates the conditions for negotiation of meaning in the classroom.

**Examples, Barriers, and Breakthroughs**

Based on the previous theoretical platform, a two-phase experiment in French 102, Beginning French 2, was designed to provide data in answer to the question, “Will POGIL inquiry lessons lead to greater proficiency in French 102 at Ball State University?” During the first phase, learning teams in the field-testing class worked with newly developed POGIL lessons one hour per week for a four-hour course. The professor and the learners observed areas for improvement.

When using the fonts and formats recommended for high school chemistry POGIL activities, learners in the field-testing group had trouble distinguishing between the types of reading needed to follow directions, draw conclusions from the sample text, and evaluate their work. They tended to approach all text in the second language with equal bewildering. Students sometimes did not turn the page if an activity continued. To alleviate this confusion, different fonts indicate the function of different types of text, evaluations appear on separate sheets, and the end of an activity is indicated by a stop sign (Figure 12.1).

In order to create a collaborative dialogue culture (Swain, 2000), the learners must be able to request information from each other in L2. In the beginning of field testing, students practiced writing questions and interviewing one another in role play. Each team member had a list of suggested questions to use while président (manager), liaison, archiviste (recorder), or observateur (observer). These communicative activities did not contribute to team cohesion, however. The facilitator had to ask the teams to form for several weeks, even though all students knew that Thursdays were for POGIL lessons, and there was a delay in understanding that procedure (speaking French) trumped task completion (solution finding).
To circumvent these problems in the second phase, where an experimental group of French 102 learned specific objectives through weekly POGIL lessons and a control group was taught through traditional lecture, two new activities were added. The first activity required learners in both groups to discover their fictional family by playing an interactive four-way blind game. In the example in Figure 12.2, Chagall the cat will find his owner when another student responds to “Quelle est ta nationalité?” with “Je suis Québécoise.” The game serves several purposes: (a) It reviews interview questions from French 101; (b) the family’s varied nationalities highlight issues
in the French-speaking world; (c) the families constitute random POGIL
teams of four, which allows for subsequent distribution of cards that define
the roles for the four officers; and (d) the quiz that followed the activity cre-
ated baseline scores in interview skills for the control (average 98.47%) and
experimental (average 98.66%) groups (Guillaud, 2014).

The experimental POGIL teams also added a practice activity with easy
French objectives to hone procedural skills. This was based on finding and
cognates, homonyms, and new vocabulary in a Cinderella story
(Fassett, 1914). The professor pointed out those same vocabulary categories
to the control group during lecture (post Cinderella quiz control average:
65%; experimental: 83%). The Cinderella unit provided practice with pro-
cedural issues such as the following:

- Playing the roles of manager, recorder, liaison, and observer
- Speaking French to solve a problem within a group
- Reading text for meaning
- Using text as a database for guided inquiry (e.g., finding cognates)
- Following a guided-inquiry activity written in French

With the changing of fonts and the addition of the team-building and
procedural practice units, the experimental group formed teams and assigned
roles spontaneously at the beginning of each weekly POGIL lesson. Learners
also read and followed procedures more smoothly in the experimental group
as opposed to the field-testing group of the previous semester.

The text for the second POGIL lesson provided examples of differing
prepositions to indicate origins and destinations. Following a review of the
conjugations of the verbs “to go to” and “to come from,” students read model
sentences using countries and regions where French is spoken. The experi-
mental POGIL teams were guided to categorize the countries by gender to

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Figure 12.2. An example of an individual’s card for the family game.

<table>
<thead>
<tr>
<th>Ton rôle et ta famille</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tu joues le rôle du chat Chagall, 8 ans.</td>
</tr>
<tr>
<td>Tu tues les souris à la ferme—C’est une sorte de profession.</td>
</tr>
<tr>
<td>Tu aimes embêter le chien Fragonard.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ta famille:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ta maitresse s’appelle Lucie, elle se considère Canadienne.</td>
</tr>
<tr>
<td>Ton autre maitresse se considère Québéquoise.</td>
</tr>
<tr>
<td>Le chien s’appelle Fragonard.</td>
</tr>
</tbody>
</table>
discover that one goes “en” a feminine country, “au” a masculine country, and “aux” a plural country, and that one comes “de” a feminine country, “du” a masculine country, and “des” a plural country. The control group was told the rule during lecture. Though the experimental group earned significantly higher scores than the control group (see Figure 12.3 and Table 12.2), there was some initial resistance to inquiry learning. “Just tell us the answer!” (Guillaud, 2014, pp. 208–210) was a frequent complaint prior to the “aha moment” (Johnson et al., 2011). One recalcitrant learner, unaware of the preparation involved in facilitating a guided inquiry, called for “more teaching, less POGIL” (Guillaud, 2014, pp. 208–210).

The third POGIL lesson compared the number of countries that surround mainland France (nine) with those surrounding the United States (three, including Cuba), and invited learners to speculate on the cultural differences that may emerge from these geographic situations. The fourth inquiry lesson used facilitator written texts to use all the forms of regular “er,” “ir,” and “re” verbs, while discussing French colonization (Redonnet, 2003; Smith, 1990). Figure 12.4 shows the section on “ir” verbs from the lesson aimed to foster transfer from the verbs conjugated in the text to the ability to conjugate regular verbs in new contexts.

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**Figure 12.3.** Average scores for quizzes after each POGIL lesson.

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**Key:**
- Experimental group: solid line
- Control group: dotted line
<table>
<thead>
<tr>
<th>POGIL lesson</th>
<th>Lesson’s main objective</th>
<th>N control N exper.</th>
<th>t test values</th>
<th>p &lt; 0.05 significant</th>
<th>p &gt; 0.05 not significant</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Vocabulary within Cinderella</td>
<td>21 17</td>
<td>t(36) = −3.49</td>
<td>0.001</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Prepositions of origin and destination</td>
<td>25 19</td>
<td>t(42) = −3.11</td>
<td>0.003</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Rapport of culture and geography</td>
<td>27 19</td>
<td>t(44) = 0.474</td>
<td>0.638 (control superior)</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Regular verb conjugations and colonization</td>
<td>26 21</td>
<td>t(45) = −0.27</td>
<td>0.789</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Constructing questions from a reading</td>
<td>25 19</td>
<td>t(42) = −0.148</td>
<td>0.148</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Compound past formation</td>
<td>24 21</td>
<td>t(43) = −3.38</td>
<td>0.002</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>The shoemaker and the elves/The imperfect tense</td>
<td>26 19</td>
<td>t(43) = −0.648</td>
<td>0.521</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Using the imperfect tense to express nostalgia</td>
<td>26 20</td>
<td>t(44) = −2.28</td>
<td>0.028</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Choosing the fairy tales to send to Burkina pen pals</td>
<td>N/A  N/A</td>
<td>N/A = N/A</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>“The Habillats”—a tale for choosing the passé composé or the imperfect</td>
<td>24 20</td>
<td>t(42) = 0.116</td>
<td>0.908</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>A tale for choosing the relative pronouns qui/que/où</td>
<td>23 19</td>
<td>t(40) = −0.978</td>
<td>0.335</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>African tales: Why the passé simple?</td>
<td>26 19</td>
<td>t(43) = −1.8</td>
<td>0.079</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>A letter from Burkina and the partitive article</td>
<td>26 19</td>
<td>t(43) = −4.44</td>
<td>0.001</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Time machine and the future tense</td>
<td>26 19</td>
<td>t(43) = −1.33</td>
<td>0.190</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Asking pen pals questions</td>
<td>26 19</td>
<td>t(43) = −0.465</td>
<td>0.644</td>
<td></td>
</tr>
</tbody>
</table>
POGIL 4B: Le deuxième groupe de verbes

10 minutes jusqu’au stop:
Ensemble dans votre groupe de quatre: Répondez aux questions à partir de vos observations du texte/ des données.

Données:
Beaucoup de ces colonies en Amérique finissent avec l’ancien régime. En 1804, Haïti réussit à déclarer son indépendance. Ce n’est pas sans des difficultés qui aigrissent le peuple et engendrent pauvreté et corruption. Les anciens colons veulent punir les esclaves en révolte et se faire rembourser pour leur propriété. Les États-Unis choisissent de ne pas reconnaître le nouveau pays. On pense peut-être ainsi: «Si les anciens esclaves peuvent bâtir une nation, pourquoi mon esclave voudrait m’obéir? Je réfléchis et je dis non à Haïti.» Comment toi et tes camarades de classe réagissez-vous? Et toi? Comment réagis-tu? Es-tu choqué(e)? Nous choisissons à partir d’une situation bien différente aujourd’hui, oui ou non?

Avec le «Grand Dérrangement» en 1755 les Anglais démolissent les fermes en Acadie. La déportation et la confiscation de leurs terres est terrible pour les Acadiens francophones. Beaucoup (10,000 sur 20,000) périssent pendant le voyage. Le «Cajun» est un Acadien qui finit en Louisiane.

Questions sur les données 4B:
4B 1. Quelles sortes de verbes sont soulignées?
4B 2. Quelles terminaisons y a-t-il pour ces verbes?
   Je ________  Tu ________  Il ________  Nous ________  Vous ________
   Ils ________
4B 3. Le conflit en Acadie est entre quelles superpuissances européennes?

2 minutes:
Archivistes: Écrivez les réponses aux questions 4B 1–3 sur votre feuille.
Liaisons: Écrivez les réponses au tableau. Si vous avez une question dans le groupe, demandez au Président si vous devriez circuler pour apprendre le raisonnement des autres groupes.
Some learners learned to appreciate using French as a tool. One student reported that the best thing about POGIL lessons was "being able to speak the language and not be too criticized on how we were saying it" (Guillaud, 2014, pp. 208–210). Here, she revealed a hidden benefit for team inquiry: L2 ceases to be an object of performance, with all the inherent possibility of losing face in front of the class, but instead becomes a vehicle for communicating and accomplishing a team goal.

POGIL lessons 5, 7, 8, 10, 11, 12, and 13 all followed the format of using fairy tales to discover the use of grammatical structures through

- asking questions;
- using and forming past tenses: the imperfect, the compound past, and the “passé simple”;
- using three relative pronouns to express “that” in French; and
- dividing quantities for consumption with the partitive article.

Lesson 6 required using a flow chart to form the compound past correctly. During this POGIL activity, the teams spoke entirely in French. Because this concept is extremely complicated grammatically, it was particularly important that the experimental group formed the compound on the quiz significantly better than the control group. One POGIL learner commented in an end-of-study survey, “We know more collectively” (Guillaud, 2014, pp. 208–210).

Lesson 14 employed role play and the future tense as the teams chose a historic or fairy tale character to warn about what was going to happen. Learners in the experimental group reported benefits to learning through inquiry:

- “Working with other students and not on my own”
- “Working with others and getting different opinions and ideas”
- “Working with others and on a time crunch”
- “Learning from literature and seeing how words and verb forms fit together as a whole”
- “The way we had to interact with each other speaking in French” (Guillaud, 2014, pp. 208–210)

Teams decided how they wished to communicate with their collective pen pals, a class of ninth graders in the village of Niégo, Burkina Faso, in lessons 9 and 15. Students composed questions and thank-you notes and decided which of their original fairy tales to send for critique. When asked how the course's cultural elements were highlighted in the POGIL units, responses varied among the following:
• “They were adequate.”
• “Very informative and will probably help in the future of my French learning.”
• “Very useful and informing.”
• “Not as fun, because the ideas did not come through immediately.”
• “Extremely helpful to me learning French culture as well as speaking French.” (Guillaud, 2014, pp. 208–210)

The first research question was “Will POGIL inquiry lessons lead to greater proficiency in French 102 at Ball State University?” To answer this question, learners in both the control group and the experimental group took a quiz based on the unit objective after each lecture (control) and POGIL (experimental) lesson. The average score for all quizzes taken by the POGIL group was 81%, and the average score for the lecture group was 71% (Guillaud, 2014, p. 114). The experimental group outperformed the control group on every post-unit quiz except for POGIL lesson 3 on the influence of geography on culture. The quiz asked learners to identify the countries surrounding mainland France. This task was one of pure memorization, and it is possible that the quiz did not reflect the link between geography and culture as well as it might.

In this action research project, where the facilitator and author of the POGIL lessons was also the researcher, the learning outcomes through POGIL lessons were consistently higher than those for learners taught through lecture. Though three normative lessons were taught through lecture to both the experimental and control groups, with nearly identical assessment scores, this conclusion can be further corroborated when other facilitators use these lessons and obtain additional data. Once others have used and reviewed this POGIL curriculum, the process of endorsement by the POGIL organization can begin, and a deeper and richer data set can then ensue.

**Information Literacy: A Case Study**

Information literacy instruction, also referred to as research instruction and library instruction, is the umbrella term used to encompass multiple knowledge-seeking and information-seeking information technology and research skills. In the context of higher education, an information-literate individual is someone who is able to do the following:

- Determine the extent of information needed.
- Access the needed information effectively and efficiently.
• Evaluate information and its sources critically.
• Incorporate selected information into one's knowledge base.
• Use information effectively to accomplish a specific purpose.
• Understand the economic, legal, and social issues surrounding the use of information and access and use information ethically and legally (Association of College and Research Libraries [ACRL], 2000).

Information literacy is defined as the "set of integrated abilities encompassing the reflective discovery of information, the understanding of how information is produced and valued, and the use of information in creating new knowledge and participating ethically in communities of learning" (ACRL, 2016, p. 3).

Typically, college students learn fundamental information literacy skills during their first year of college, often in a core college course, and these skills are almost always taught by a guest librarian holding a master's in library science degree. As students begin taking courses in their intended major, a librarian who specializes in their discipline (e.g., biology, engineering) teaches a more in-depth workshop on the skills and concepts particular to that discipline. For example, business majors may learn how to find company, industry, and marketing data, while education majors learn how to locate children's literature, lesson plans, and educational research.

Students typically participate in information literacy instruction as a single class session (activity) integrated into 1, 2, or 3 of their enrolled courses. At most, librarians have around 150 minutes to teach students everything they need to be successful in doing academic research. Given this small amount of instruction time, it is imperative that librarians use a successful learning model such as POGIL to structure learning activities to maximize student learning in each information literacy session. The POGIL approach to teaching information literacy gives the structure to learning that students need to grasp concepts and skills and apply them to all courses in their core and major.

Using POGIL to teach information literacy provides the opportunity for college students to learn valuable research skills and concepts at a deep level. POGIL's basis in social constructivist learning theory provides the framework for active engagement with research tools and essential skills to solve information problems. Rather than being shown how to use research tools, as is common in library instruction, students are led through guided-inquiry activities with critical thinking questions that prompt them to think about the how and why components of academic research. For example, using POGIL allows students to learn how to find peer-reviewed scholarly articles,
as well as why they exist within the scholarly communication life cycle, and why and when to use them.

**Examples, Barriers, and Breakthroughs**

Librarians at Boise State University have taught the "Search Strategies and Information Evaluation" activity to 70 to 130 sections of University Foundations 100 (UF 100) every semester beginning in fall 2011. Every Boise State student completes UF 100 as part of the Foundational Studies Program curriculum, which comprises the university's core education. The Search Strategies and Information Evaluation activity can be modified by instructors and librarians and integrated into any first-year college course. Considering its combination of skills, concepts, and values and dispositions, the activity lends itself to POGIL learning. The learning cycle is used to guide students through information-seeking and information evaluation activities before introducing them to the targeted concept or skill and subsequently applying the concept or skill.

Students examine two academic articles (Figure 12.5) to generate three criteria for evaluating information of their own (exploration phase) before they are introduced to a common model used to evaluate information (concept/term introduction phase). The students then use the model to evaluate the reliability of two websites (application phase) (Figure 12.6). This lesson plan encompasses a skill (evaluating information), a concept (CRAAP model), and acquiring a disposition toward information (valuing the quality of information). CRAAP is an acronym for evaluating information: C—currency, R—relevance, A—authority, A—accuracy, and P—purpose. This model was created at California State University, Chico, and is widely used by academic librarians to teach information evaluation skills (Meriam Library, 2010).

In another section of the activity, students develop and apply intentional search strategies for locating articles, including selecting keywords and research databases. Prior to class, students are asked to watch two brief videos that provide the basics of the article database Academic Search Premier and the purpose and characteristics of academic (peer-reviewed) articles. During the in-class session, students begin by viewing a three-minute video about rising sea levels and writing down two to three main ideas that the speaker mentions (Figure 12.7). These main ideas are turned into search terms and phrases for searching a library research database (Figure 12.8). The critical thinking questions ask teams to evaluate their search results in terms of usefulness, list other search strategies they use to find information, and explain how the research databases could be used in
Figure 12.5. Team Task 2: Evaluating articles and evaluation criteria (exploration phase).

Team Task 2 (8 minutes)

Instructions:
1. View the two articles.
2. List three criteria for evaluating the quality of the articles and explain how each criterion helps you evaluate information.

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Explain how this criterion helps you evaluate information</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</table>

Critical thinking questions:
1. Would you use these articles for a research paper or project? Explain.
2. Which article has characteristics of an academic article? When is it appropriate to use academic articles? When is it appropriate to use other types of articles?

other courses they are taking. The last team task represents the synthesis stage of the activity (Figure 12.9).

If we had designed the activity to introduce students to the CRAAP model before asking them their own criteria for evaluating information, the activity would not incorporate POGIL learning principles. Instead, we asked students to discuss their personal criteria for evaluating information before showing them the CRAAP model. In practice, students’ own criteria for evaluating information often speaks to a couple of the CRAAP criteria, such as the website’s domain (.edu, .com, etc.), which corresponds to the website’s authority, and the presence of a bibliography, which speaks to the website’s accuracy. However, we have found that they have not always thought about other criteria such as currency, purpose, relevancy, and more specific aspects of accuracy and authority. After introducing students to the CRAAP model, we ask them to evaluate two websites using the CRAAP criteria, a very challenging activity. The activity provides for a rich discussion on the intricacies of evaluating any piece of information for reliability.

Process skills such as teamwork, information processing, and critical thinking are integral parts of POGIL learning. Moog and Spencer (2008)
Figure 12.6. Team Task 3: Evaluating websites using the CRAAP criteria (application phase).

Team Task 3 (10 minutes)

Instructions:
1. Imagine you are trying to find facts and statistics about rising sea levels, specifically as it relates to global warming.
2. View both websites, using the links on the website for today's class.
3. Evaluate the information you find in each website using the CRAAP criteria.
4. Answer the critical thinking questions.

Surging Seas: http://sealevel.climatecentral.org


<table>
<thead>
<tr>
<th>Criteria</th>
<th>Surging Seas</th>
<th>Climate.gov (NOAA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Currency</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Relevancy</td>
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<td></td>
</tr>
<tr>
<td>Authority</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accuracy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Purpose</td>
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</tr>
</tbody>
</table>

Critical thinking questions
1. Would you use these websites for a research paper or project? Explain.
2. What should you do if an information source does not meet the CRAAP criteria?

describe the importance of process skills as a backdrop to content skills in POGIL learning:

Within the POGIL philosophy, the development of process skills . . . is a specific and intentional focus of the classroom implementation; improving these skills will not only complement and enhance the mastery of course content for the student, but will also help achieve the overall goals of the institution. (p. 6)
Figure 12.7. Team Task 1, Part A: Creating a search strategy for your topic (application phase).

<table>
<thead>
<tr>
<th>Team Task 1 (20 minutes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inquiry question: What are the causes of, ecological consequences of, or political and policy response to southern Florida's sea level rise that are linked to climate change?</td>
</tr>
</tbody>
</table>

**Part A. (5 minutes)**

**Instructions:**
1. As we watch this video, write down two to three main ideas that the speaker mentions. ("Tidal Flooding and Sea Level Rise: The Growing Impacts of Global Warming")

2. Brainstorm related terms for at least one of the ideas from step #1.

   *Example: Related terms for the idea of iPads -> mobile devices, tablets, technology*

3. Create one or more searches by connecting different ideas from steps #1 or #2 with the word AND. Write your search(es) in the space provided.

   *Examples: sleep AND grades; iPads AND education AND grades*

4. Write your team's search on the board.

See chapter 3 for more about process skills, including definitions, guidelines for team roles and interactions, and a description of how activities and classroom facilitation develop process skills.

While the Search Strategies and Information Evaluation activity involves teamwork and critical thinking, it is primarily designed to help develop information-processing skills. Schunk (2012) describes information processing as "a generic name applied to theoretical perspectives dealing with the sequence and execution of cognitive events" (p. 164). Snowman, McCown, and Biehler (2012) further describe information-processing theory as an explanation of the acquisition, storage, and recall of information. One such application of information processing involves using mnemonic techniques to help students learn. In the Search Strategies and Information Evaluation activity, students learn the acronym CRAAP as an easy way to remember how to evaluate information. Each letter
represents one aspect of information that should be considered when assessing the reliability of a website, a book, an article, or other piece of information.

Another way the theory of information processing is important to learning is through improving students’ metacognitive skills. Reflective questions are asked throughout the activity for students to assess their search and evaluation skills. Such questions include the following:

1. What search strategies did your team use during your search(es)? Which strategies were most helpful to your team? (Figure 12.8)
2. How can reflecting on your search results and evaluating the reliability of information help you be successful in your research projects? (Figure 12.9)

Other methods of using information processing in this activity include organizing information (e.g., “Imagine you are describing what you learned from today’s class to a good friend. List two tips you would pass on” [Figure 12.9]) and increasing meaningfulness (e.g., “Describe a scenario outside of college life in which you could use any of today’s research skills” [Figure 12.9]).

Figure 12.8. Team Task 1, Part B: Creating a search for your topic (application phase).

<table>
<thead>
<tr>
<th>Part B. (7 minutes)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Instructions:</strong></td>
</tr>
<tr>
<td>1. Go to the website for today’s class.</td>
</tr>
<tr>
<td>2. Select a research database to use.</td>
</tr>
<tr>
<td>3. Type your team’s search(es) into one or more of the research databases.</td>
</tr>
<tr>
<td>4. Limit your results to scholarly/peer-reviewed journal articles.</td>
</tr>
<tr>
<td>5. Look at your results. If you are not satisfied with the articles you found, redo your search by changing your keywords or switching databases.</td>
</tr>
<tr>
<td>6. E-mail one of the articles, with its citation, to yourself or someone in your team.</td>
</tr>
<tr>
<td>7. Answer the critical thinking questions.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Critical thinking questions:</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. What search strategies did your team use during your search(es)? Which strategies were most helpful to your team?</td>
</tr>
<tr>
<td>2. What other search strategies do you use to find information for research projects?</td>
</tr>
<tr>
<td>3. How could you use the research databases for other courses you are taking?</td>
</tr>
</tbody>
</table>
Team Task 4 (5 minutes)

**Critical thinking questions:**
1. (Self-assessment of information-processing skill) How can reflecting on your search results and evaluating the reliability of information help you be successful in your research projects?
2. (Self-assessment of content learning objectives) Imagine you are describing what you learned from today’s class to a good friend. List two tips that you would pass on.
3. (Self-assessment of content learning objectives) Describe a scenario outside of college life in which you could use any of today’s research skills.

**Information Literacy Standards**
Two documents created by the ACRL, a section of the American Library Association, inform information literacy instruction in higher education:

1. *Information Literacy Competency Standards for Higher Education* (2000)

We refer to these two documents as the Standards and the Framework. The Standards were created in 2000 and have been used by thousands of academic librarians as the basis of information literacy instruction. The Framework, complementary to the Standards, was adopted by the ACRL board in January 2016. The Standards set forth standards, performance indicators, and outcomes, while the Framework defines a set of interconnected core concepts about information.

The Standards document states that it “provides a framework for assessing the information literate individual” (ACRL, 2000). It encompasses both higher-order and lower-order thinking skills based on Bloom’s taxonomy of educational objectives. The Search Strategies and Information Evaluation activity is intended for first-year college students and is accordingly based on the first three standards (ACRL, 2000):

1. “Standard One: The information literate student determines the nature and extent of the information needed” (p. 8).
2. “Standard Two: The information literate student accesses needed information effectively and efficiently” (p. 9).
3. “Standard Three: The information literate student evaluates information and its sources critically and incorporates selected information into his or her knowledge base and value system” (p. 11).
**TABLE 12.3**

The POGIL Response to the ACRL Standards

<table>
<thead>
<tr>
<th><strong>ACRL (2000) Standards outcomes</strong></th>
<th><strong>Corresponding POGIL team task</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.2.d: Identifies the purpose and audience of potential sources</td>
<td>Team Task 2: Examines two articles. Critical thinking question asks students the characteristics of an academic article, when it is appropriate to use them, and when to use other types of articles.</td>
</tr>
<tr>
<td>2.2.b: Identifies keywords, synonyms, and related terms for the information needed</td>
<td>Team Task 1: Instructions direct teams to extract keywords mentioned in a short video. Teams then brainstorm related terms.</td>
</tr>
<tr>
<td>2.2.d: Constructs a search strategy using appropriate commands for the information retrieval system selected</td>
<td>Team Task 1: Instructions direct teams to create searches using their keywords and related terms and the Boolean command &quot;AND.&quot;</td>
</tr>
<tr>
<td>2.4.a: Assesses the quantity, quality, and relevance of the search results to determine whether alternative information retrieval systems or investigative methods should be utilized</td>
<td>Team Task 1: Critical thinking question asks students to identify their search strategies and reflect on which strategies were most helpful in that task.</td>
</tr>
<tr>
<td>3.3.a: Determines whether information satisfies the research or other information needed</td>
<td>Team Task 2: Asks students to review two articles and if they would use them for a research paper or project.</td>
</tr>
<tr>
<td>3.2.a: Examines and compares information from various sources in order to evaluate reliability, validity, accuracy, authority, timeliness, and point of view or bias</td>
<td>Team Task 2: Students brainstorm the characteristics of information they use to evaluate the reliability of information.</td>
</tr>
<tr>
<td></td>
<td>Team Task 3: Provided with an information-seeking scenario, students are asked to evaluate the reliability of two websites on that topic.</td>
</tr>
</tbody>
</table>

Table 12.3 specifies the exact Standards outcome to which each of the POGIL team activity speaks. Standards four and five, not used in this activity, address using information to accomplish a specific purpose and using information ethically and legally (ACRL, 2000).

In contrast to the Standards, the Framework includes six core concepts or threshold concepts, with accompanying learning goals (knowledge practices) and dispositions. The Framework defines threshold concepts as "[i]deas
IMPLEMENTING

in any discipline that are passageways or portals to enlarged understanding or ways of thinking and practicing within that discipline” (ACRL, 2016, p. 2). Knowledge practices are the learning goals related to each threshold concept. Dispositions “[d]escribe ways in which to address the affective, attitudinal, or valuing dimension of learning” (ACRL, 2016, p. 2). The six threshold concepts in the Framework are as follows:

1. Authority is constructed and contextual
2. Information creation as a process
3. Information has value
4. Research as inquiry
5. Scholarship as conversation
6. Searching as strategic exploration

The Search Strategies and Information Evaluation activity focuses on the last threshold concept: searching as strategic exploration. While we could have chosen any of the threshold concepts to focus on, this concept is incredibly important for first-year students. The Framework document further defines the concept of searching as strategic exploration: “Searching for information is often nonlinear and iterative, requiring the evaluation of a range of information sources and the mental flexibility to pursue alternate avenues as new understanding develops” (ACRL, 2016, p. 9). This concept encompasses inquiry, discovery, and serendipity, and the Framework notes that “novice learners tend to use few search strategies, while experts select from various search strategies” (ACRL, 2016, p. 9).

Using the concept of searching as strategic exploration as a lens to teach first-year students about information allowed us to integrate layers of searching and reflection into the Search Strategies and Information Evaluation activity. Team Task 1, Part A (Figure 12.7) leads students to generate key-words, alternate keywords (synonyms), and search strings using the “AND” Boolean operator. Part B (Figure 12.8) directs students to choose an article database, enter their search string (and if they did not find relevant results, to change keywords or databases), and subsequently answer three critical thinking questions:

1. What search strategies did your team use during your search(es)? Which strategies were most helpful to your team?
2. What other search strategies do you use to find information for research projects?
3. How could you use the research databases for other courses you are taking?
By asking students to reflect on their most successful search strategies, they learn that searching is strategic—individuals make decisions about where and how to search. The first question speaks to one of the Framework’s knowledge practices: “Learners who are developing their information literacy abilities design and refine needs and search strategies as necessary, based on search results” (ACRL, 2016, p. 9). The accompanying disposition states these learners “understand that first attempts at searching do not always produce adequate results” (ACRL, 2016, p. 9). The second question asks students to expand their thoughts and think about other search strategies they might use that have not been mentioned in class. This builds on their previous knowledge of searching.

Summary

Based on the success of using POGIL in L2 learning and information literacy, and the evidence of learning in many other non-STEM disciplines, instructors in middle school, secondary education, and post-secondary education, in any discipline, can and should consider using POGIL in their classroom. Employing POGIL is beneficial when the following results are desired:

- Improved mastery of content and depth of learning
- Transfer of learning
- Increase in exam scores and course grades
- Increase in standardized test scores
- Lower course attrition rates
- Social learning
- Increased student engagement
- Improved process skills (teamwork, information processing, critical thinking, problem-solving, management, oral and written communication, and assessment)
- Increased student perceptions of the value of learning in teams

Instructors new to POGIL might be excited about trying this new learning method, but unsure of where to begin. We offer these thoughts:

- Try POGIL in one new lesson plan each semester. Do not feel you must change every lesson prior to the beginning of the semester.
- Locate examples of POGIL activities (even if there are none for your discipline) and think about how they can be applied to the concepts and skills in your discipline. The POGIL Project website
IMPLEMENTING (www.POGIL.org) and searching the Internet for “POGIL lesson plan” are good strategies for finding examples.

- Search the literature in your discipline for examples of lessons that use active learning. Then apply the POGIL framework to the lesson and tweak for your personal use.
- Find models that represent artifacts that the experts in your field would use to form concepts and theories and ask students guiding questions to help them develop those concepts.

Success in the POGIL classroom comes from following the students: If you judge your teaching by how much you are helping your students, what works for them and what doesn’t work, you will succeed.

—A POGIL practitioner of five years

Notes

1. Vygotskii died in Russia in 1934. His theories became more globally known with the publication of his work in 1962 and 1978 (Whyte, 2003).
2. Suggested texts for use in POGIL units can be written for the lesson by the facilitator; taken from the course's textbook; or inspired from publications found in the Gutenberg project, a list of works in the public domain.

References


