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A Guided-Inquiry Activity for Introducing Students to Figures from Primary Scientific Literature

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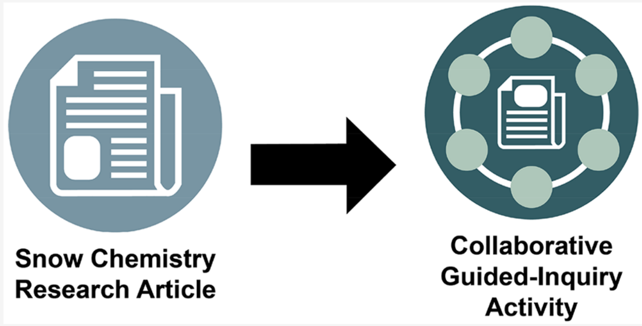
ABSTRACT: Reading and understanding scientific literature is an essential skill for any scientist to learn. While students' scientific literacy can be improved by reading research articles, an article's technical language and structure can hinder students' understanding of the scientific material. Furthermore, many students struggle with interpreting graphs and other models of data commonly found in scientific literature. To introduce students to scientific literature and promote improved understanding of data and graphs, we developed a guided-inquiry activity adapted from a research article on snow chemistry and implemented it in a general chemistry laboratory course. Here, we describe how we adapted figures from the primary literature source and developed questions to scaffold the guided-inquiry activity. Results from semi-structured qualitative interviews suggest that students learn about snow chemistry processes and engage in scientific practices, including data analysis and interpretation, through this activity. This activity is applicable in other introductory science courses as educators can adapt most scientific articles into a guided-inquiry activity.



KEYWORDS: *First-Year Undergraduate, General, Environmental Chemistry, Collaborative, Cooperative Learning, Inquiry-Based, Discovery Learning*

INTRODUCTION

Learning how to read and understand primary literature is an important practice within STEM disciplines.[1] Scientists communicate new research results through peer-reviewed literature, making it a major component of scientific communication and the scientific process. Engaging students in reading primary literature is an important instructional tool for upper- and lower-level science courses as it leads students to critically analyze the investigative process of science.[2,3] In recognition of this, the American Chemical Society Committee on Professional Training lists evaluating technical articles as an essential skill for graduates of American Chemical Society-approved programs.[1] While reading primary literature can increase students' scientific literacy, the format and technical jargon of scientific literature are often barriers to students' comprehension.[4,5] Therefore, it is crucial to develop instructional activities that expose and teach students how to read primary literature and analyze and interpret the presented data.[3]

Instructional activities that incorporate scientific literature are part of a greater reform effort that introduces students to the norms and practices of scientific disciplines, as outlined in the Framework for the Next Generation Science Standards (NGSS).[6] Within the Framework, researchers disassembled scientific processes into the Science and Engineering Practices, which include developing and using models, analyzing and interpreting data, and engaging in argument from evidence.[6,7] These particular practices are important skills for students to learn since graphs communicate relationships between measured variables in science using visualizations.[8−10] While the Framework defines proficiency for K-12 students, college graduates often lack experience interpreting graphs and constructing claims, and thus continue to struggle with using and applying graphs where scientists commonly employ them.[9] Instructors can introduce undergraduate students to graphs and encourage them to construct claims by utilizing primary literature in the classroom.

Several approaches have been utilized to teach undergraduate students how to read and interpret data within primary literature.[3,11−22] Most of these approaches have been implemented in upper-level courses, such as organic chemistry and analytical chemistry,[19−22] with only a handful appearing in introductory general chemistry courses.[13−19] Of these

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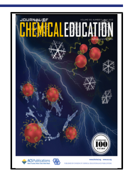

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approaches, there are two general formats for scaffolding students' learning: a nonspecific assignment that can be applied to most scientific articles and a specific assignment with questions associated with a particular article.[22] The first format shows commonalities across primary literature, such as the structure of an article, whereas the second format makes connections between the article and course content. For example, Murray[3] used the second format to develop four Process-Oriented Guided-Inquiry Learning (POGIL) activities based on primary literature for their Biochemistry I and II courses. Student participation in the POGIL activities had a positive influence on students' perceived gains as they self-reported improved abilities to read the primary literature and increased knowledge of the topics.[3] While POGIL was used to introduce biochemistry students to primary literature,[3] it has not been described as an approach for teaching general chemistry students how to read and interpret data within primary literature.

Instead of having students read full articles from the primary literature, some instructors focus on developing students' process skills (i.e., critical thinking and communication skills learned alongside course content) using assignments that focus on data excerpted from articles. In their recently published article, Hunter and Kovarik[20] describe how they designed and implemented over 40 primary literature-based assignments in analytical and instrumental analysis courses. These assignments had students analyze unaltered data from primary literature and included questions to scaffold students' interpretation of figures, tables, etc.[20] While activities focusing solely on data excerpts from primary literature can develop process skills and be applied more readily in the classroom, activities like this focus more on interpreting data from primary literature instead of learning how to read the primary literature.

Here, we describe the development, implementation, and evaluation of a guided-inquiry activity, focused on exposure to primary literature and interpretation of research results, in a one-semester general chemistry laboratory course.[23] This guided-inquiry activity was designed using a research article by Domine et al.[24] and implemented as part of a course-based undergraduate research experience (CURE)[25] focused on snow chemistry research.[23] Providing students with research experiences that are contextualized in environmental chemistry teaches students foundational general chemistry content and experimental techniques and helps them recognize the relationship between course content and the real world.[23] This course is described as an authentic research experience for undergraduate students because the students participate in the primary course instructor's research program[23] and many of its components are embedded in science practices identified by NGSS.[6,26] For example, in this course students learn general chemistry concepts (e.g., molarity) and laboratory skills (e.g., titration) as they study authentic snow samples from the Arctic.[23] Because students need a conceptual understanding of snow chemistry processes prior to conducting snow chemistry research, the goals of this activity were to introduce students to scientific literature, teach interpretation of graphical data, and promote understanding of how inorganic ions enter and are distributed within the Arctic snowpack. Practitioners who are looking to support students' graphical interpretation skills using data from scientific literature and implement guided-inquiry activities within their classroom should find this guided-inquiry activity insightful.

GUIDED-INQUIRY ACTIVITY DESIGN PRINCIPLES

The activity presented here is inspired by POGIL, which is a student-centered, content-neutral teaching practice that is implemented in hundreds of high school and college science classrooms across the country.[27−30] In a POGIL classroom, students learn the content of a specific discipline while working on guided inquiry activities in self-managed groups of three to four students.[27,30] Contrary to most teaching approaches, the instructor's role in a POGIL classroom is to facilitate learning and process skill development by probing students for understanding rather than passively delivering content.[27,30]

In the POGIL acronym, process-oriented refers to the intentional development of students' process skills.[27,30] Process skills are thinking, learning, communication, and interpersonal skills separate from course content, but essential for students' long-term growth as scientists.[27,30] By purposefully selecting one or two process skills to focus on for each POGIL activity, instructors prepare students with skills that are applicable in the real world.[27,30] Guided inquiry refers to the scaffolding of the activity, specifically how the activity follows The Learning Cycle.[27,28,30−32] The Learning Cycle is a three-phase cycle where students are guided to understand key concepts through: (1) exploration, (2) concept invention and term introduction, and (3) application.[27,28,30−32] We describe our application of The Learning Cycle to our POGIL-inspired guided-inquiry activity in our Description of the Activity section.

When students participate in POGIL activities that are scaffolded using The Learning Cycle,[27,28,30−32] they are given space to learn fundamental conceptual knowledge, connect and apply knowledge to new situations, and ask clarifying questions in a collaborative environment before leaving class.[33] Through POGIL activities, students also learn skills that align with several of the NGSS Science and Engineering Practices, including developing and using models, analyzing and interpreting data, and constructing explanations,[6] and develop process skills, such as teamwork and problem solving.[27,30] Our guided-inquiry activity was designed using these principles of POGIL pedagogy, though we did not seek endorsement by The POGIL Project.[34]

IMPLEMENTATION AND EVALUATION OF THE ACTIVITY

Course Context

The guided-inquiry activity described herein was implemented at the University of Michigan, a large, research-intensive university in the Midwest. The general chemistry laboratory course was designed as a CURE contextualized in snow chemistry research[23] and provided students with an authentic research experience as they learned general chemistry topics identified in the American Chemical Society General Chemistry Anchoring Concepts Content Map.[35,36] For the semester in which the guided-inquiry activity was implemented (Fall 2019), the course enrolled 35 students, most of whom were first- and second-year undergraduate students and were primarily not prospective chemistry majors.

A research paper scavenger hunt assignment was used in previous course iterations to introduce the students to the same snow chemistry research article.[23] In this assignment provided in the Supporting Information, students read the primary literature article[24] and responded to a series of questions about the article. These questions focused on general

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Table 1. Model Summaries and Learning Objectives of the Snow Chemistry Guided-Inquiry Activity

Model Number	Model Name	Model-Specific Learning Objectives
1	Chloride (Cl^-) in Arctic Snow	Define molarity and describe the general trend of the graph
2	Chloride (Cl^-) in Layers of Arctic Snow	Compare how snow layers relate to the graph in Model 1 and hypothesize why chloride concentration changes between snow layers
3	Chloride (Cl^-), Sodium (Na^+), and Bromide (Br^-) in Arctic Snow	Expand understanding from chloride to sodium and bromide and analyze trends in the graph
4	How Chloride (Cl^-), Sodium (Na^+), and Bromide (Br^-) get into the Arctic Snow	Identify two mechanisms by which ions from the seawater can enter the snowpack
Extension Question	Chloride (Cl^-) in Layers of Arctic Snow over Time	Analyze chloride concentration in layers of snow over time and compare the authors' interpretations of the data to your understanding

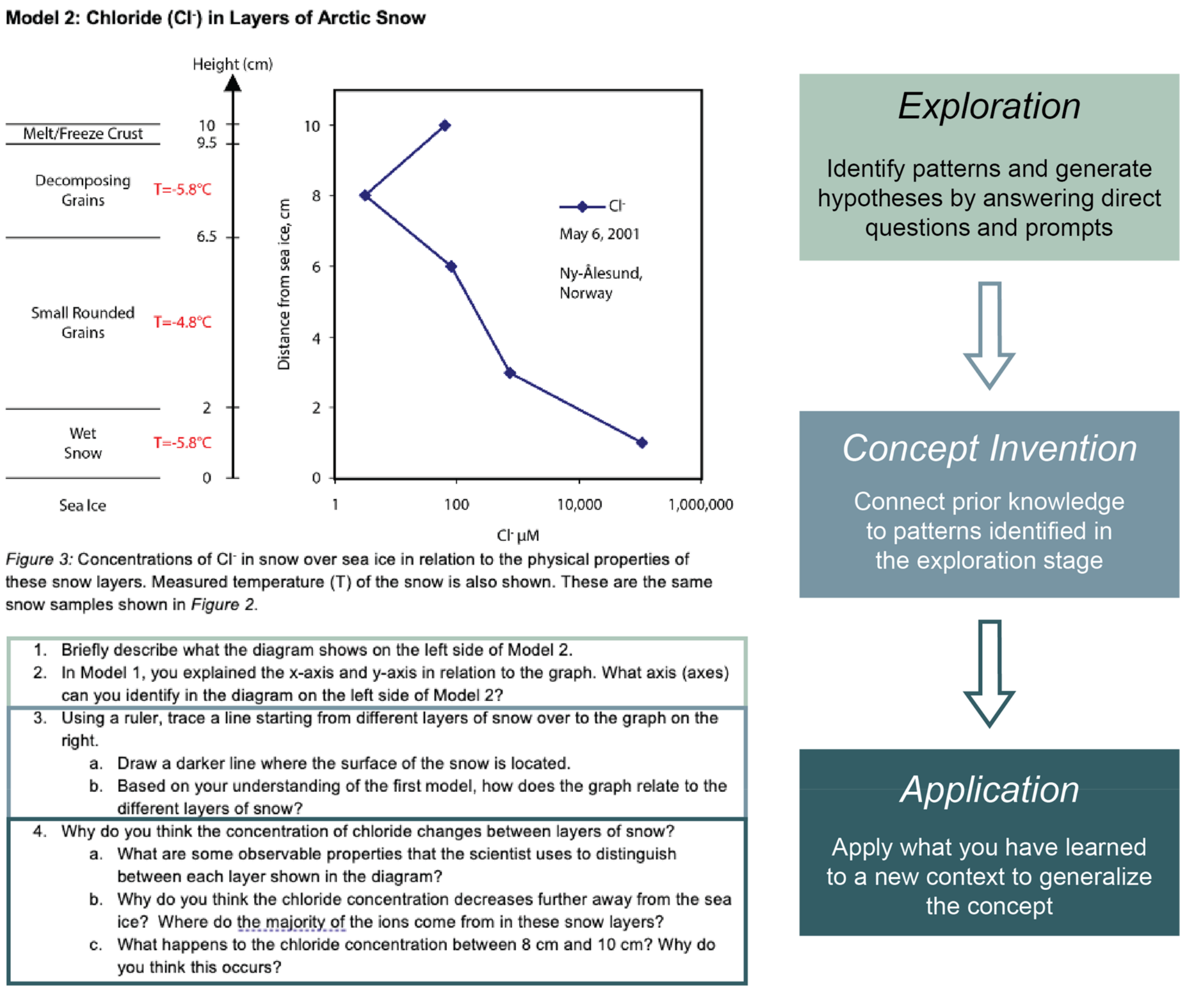

Figure 1. Schematic example of how The Learning Cycle[27,28,30−32] was operationalized within Model 2 for our guided-inquiry activity (Supporting Information, Snow Chemistry Guided-Inquiry Activity). Model 2 is based upon the primary literature source by and reproduced with permission from Domine et al.[24] Copyright (2004) Copernicus Publications. Each phase of The Learning Cycle, *exploration*, *concept invention*, and *application*, appears in Model 2 as the guiding questions explore relationships between chloride concentration and layers of snow. In Model 2, *exploration* applies to the first two questions, *concept invention* appears within the third question, and *application* is centered within the final question.

article structure, main sections, and scientific content, such as the major processes by which halides reach the snow surface. While this assignment scaffolded students learning about the manuscript, the students gained only basic knowledge of the scientific results, with limited ability to interpret the figures within the article. Therefore, the guided-inquiry activity was designed in this context, with the scavenger hunt assigned directly afterward, to scaffold students' understanding of both snow chemistry processes and key components of primary literature. Since the guided-inquiry activity was designed to be completed in groups in-class, the scavenger hunt was implemented second, as it could be completed independently outside of class. It is important to note that while the guided-inquiry activity was designed for a general chemistry laboratory course with a CURE, it is not a "wet-lab" activity.

Prior to participating in the guided-inquiry activity, students received a prelaboratory lecture about Arctic snow research from the course instructor and read the primary literature article as a prelaboratory assignment.[3] The prelaboratory assignment, provided in the Supporting Information, required students to skim the Domine et al.[24] article and take notes of

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unfamiliar terminology, questions they would like to have answered, and the primary hypothesis of the paper.[3]

The guided-inquiry activity was designed to occur over a 1 h period in a computer laboratory to provide students with ample space to work together. Two graduate student instructors and two undergraduate student instructors facilitated the activity after being trained by a graduate student with prior POGIL teaching and mentoring experience. Students were organized into 11 3−4 person groups and directed to work through the guided-inquiry assignment together. Although roles are often used in POGIL and other inquiry learning activities,[33] they were not used by the instructors in this case, as roles were not a normal part of the instructors' classroom practice. Facilitators encouraged students to critically think about the questions within the guided-inquiry assignment by offering probing questions throughout the activity. To promote the exchange of ideas between groups, students spent the last 10 min of the guided-inquiry activity sharing ideas and questions with students outside of their group. After participating in the guided-inquiry activity for approximately 1 h, students submitted one guided-inquiry assignment on behalf of their group. Next, the students spent 1 h completing the individual primary literature scavenger hunt worksheets. The remaining class time was reserved to introduce (1) a paraphrasing activity for reviewing new scientific literature and (2) a postlab assignment related to their research project. Later in the semester, students applied knowledge gained from this activity to make their own snow chemistry figures as part of their semester-long research project.

Description of the Activity

This guided-inquiry activity was initially designed as a part of a snow chemistry unit with the goals of (1) supporting student understanding of snow chemistry processes described in the primary literature[23,37] and (2) engaging students in the NGSS Science and Engineering Practices, including using models (e.g., graphs) and interpreting data. Model-specific learning objectives are described in Table 1.

The guided-inquiry activity consists of five models, each of which contains an adapted figure, a figure caption, and a series of questions based on tenets of The Learning Cycle[27,28,30−32] (Table 1). The full guided-inquiry assignment is included in the Supporting Information. We recognize that the term "model" has multiple meanings, and is used differently by the environmental chemistry community and the POGIL community; here, we define "model" as a representation of a complex phenomena[6] (e.g., graph or schematic) that scaffolds students' engagement with the guided-inquiry activity.[27] To develop the guided-inquiry assignment, the design team used Adobe Illustrator to adapt figures from the primary literature article[24] by removing details to focus the students on aspects of the figures that were critical to the goals of their research projects.[23] After the figures were adapted, the design team developed questions to guide students through the activity.

In engaging with the first model, students learn about the general chemistry terms of molarity and ions, as well as how to interpret a graph, while also learning the research result of how chloride concentrations relate to snow depth above sea ice. At the end of the model, students are asked to summarize their understanding in writing as if they were explaining the concept to someone not familiar with chemistry, allowing students to engage in general scientific written communication practices. The second model has students apply what they learned about chloride concentrations to snow layers and their physical properties (left panel of Figure 1).[24] As part of the activity centered on Model 2, students describe how the graph from Model 1 relates to snow depth and hypothesize why chloride concentrations change as a function of distance above the sea ice.

The third model has students expand their knowledge of inorganic ions in snow by exploring how snow chloride, sodium, and bromide concentrations relate to the distance above the sea ice. Students compare Models 2 and 3, noting their similarities and differences. Using fill-in-the-blank style sentence structures, students analyze the patterns in the graph and provide explanations for their conclusions. The fourth model has students compare this model to the previous three models and apply their conclusions from Model 3 to illustrate the two main processes by which chloride and sodium enter the Arctic snowpack: (1) deposition of sea spray aerosol particles to the snowpack surface and (2) upward brine migration from the sea ice surface.[24,38] The final model consists of a series of extension questions designed to have students apply their knowledge from the previous four models to a model of chloride concentrations in snow over time. This model also has students compare the primary literature authors' interpretation of the models with their understanding.

We describe our application of The Learning Cycle[27,28,30−32] using a model and guiding questions from our POGIL-inspired guided-inquiry activity in Figure 1, though The Learning Cycle appears throughout our activity as the models increase in complexity. In the first phase, exploration, students identify patterns and generate hypotheses by answering direct questions and prompts. In the second phase, concept invention and term introduction, students connect prior knowledge to patterns identified in the first phase. This is shown in Model 2 where students were asked to apply their knowledge from Model 1 to Model 2. In the last phase, application, students apply what they have learned to a new context to generalize the concept's applicability, as highlighted by the questions about snow layers and distance from the sea ice.

Instructor Preparation and Reflections

The instructors had varied backgrounds with guided-inquiry activities and POGIL[27−30,33] prior to this activity. As a result, we hope that sharing reflections from their experiences will provide practitioners with guidance to implement similar activities within their courses. Two graduate student instructors and two undergraduate student instructors implemented the guided-inquiry activity. One graduate student instructor (JLS) had previously taught high school and used POGIL extensively within his classroom, while the other graduate student instructor (MC) and two undergraduate student instructors (BF) and (NP), who were course alumni, had no prior experience with POGIL.

To prepare the team of student instructors, one graduate student (JLS) led a workshop, walking the other instructors through The Learning Cycle[27,28,30−32] and discussing how to structure dialogue and respond to students' questions with deeper questions. For example, to probe students' understanding about how the snowpack structure and physical properties correlate with chloride concentration, JLS asked one group: "Which one do you think is the most important variable? Distance from the sea ice, snow grain structure, or temperature?" For instructors who want to learn more about

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facilitating discussion during a similar guided-inquiry activity, we recommend Moon et al.,[39] Warfa et al.,[40] Stanford,[41] and Chin.[42] During our activity, the classroom was organized into "zones", where each instructor was responsible for facilitating a few groups of students. The team met periodically during the activity to discuss patterns they were noticing between groups and ways they could improve their facilitation based on the learning objectives. The team recognized that the activity contained many models, so they devised a plan in case they ran out of time for this specific activity, knowing that deep engagement in a few models would be more beneficial than trying to rush through everything.

Full reflections from each of the instructors are included in the Supporting Information. Here, we provide example anecdotal accounts as a summary to corroborate the instructors' perceptions of students' interactions with actual student data. Reflecting on their experiences as an undergraduate student, NP described how their nonchemistry engineering background made them feel "completely unfamiliar with how data is collected, processed, analyzed, and presented in a scientific study." These feelings resonated with several members of the teaching team and students in this course. After facilitating the guided-inquiry activity, BF said that "it was interesting to see students' reactions to this new way of investigating and understanding literature in the scientific context." Most of the students had a positive experience with the guided-inquiry activity, which is further discussed in the Student Feedback section. MC also found the guided-inquiry activity to be a valuable experience for the students as "it provided the students with a much more approachable way to understand scientific literature." After facilitating the guided-inquiry activity, BF "felt confident that [the] students were picking up the new material and seemed interested in learning and exploring the concepts." This instructor perception aligns with data from the students as most students reported an increased perceived conceptual understanding of snow chemistry processes as a result of the guided-inquiry activity.

Evaluation of the Activity

The guided-inquiry activity was evaluated by reviewing the 11 submitted guided-inquiry assignments and conducting semi-structured interviews with seven students (20% of the class) after they completed the guided-inquiry activity and research paper scavenger hunt assignment. After activity completion, the first-author visited a prelaboratory class session to recruit students for 1 h interviews. The student interviews provided valuable insights into the guided-inquiry activity that other data sources likely would not have captured.[43] For instance, several of the interviews captured students' perceived conceptual understanding of snow chemistry processes, and how previous experiences with POGIL influenced their perception of the activity; these thoughts may not have been captured without conducting interviews postactivity with the students. To characterize how students engaged with the activity, each of the submitted guided-inquiry assignments were analyzed to (1) determine if the students were able to complete the activity in its entirety and (2) identify the models and concepts that students understood, and those with which they had difficulty. The interview protocol prompted students to reflect on the guided-inquiry activity, the guided-inquiry group assignment, and the scavenger hunt assignment and analyze a related, unaltered figure from the same primary literature source. A copy of the interview protocol is included in the Supporting Information.

Four of the 11 groups (of 3−4 students) completed three models, six of the 11 groups completed four models, and only one group completed all five models in the guided-inquiry activity within the 1 h lab period. While most groups did not complete the full guided-inquiry activity, most groups correctly answered the guided-inquiry activity questions for models 1−3 and identified the two main mechanisms by which chloride and sodium enter and are distributed within the snowpack, thereby showing that the students gained content knowledge relevant to their research projects. Although only one group completed the final model, developing a model that integrated knowledge across the activity helped students make connections across concepts, while engaging them in several NGSS Science and Engineering Practices. In the future, instructors should provide additional time for the guided-inquiry activity to allow sufficient time to complete the activity. If additional time is not available, instructors should encourage students to complete the first three models at minimum, with completion of model 4 and the extension questions as supplemental knowledge.

■ STUDENT FEEDBACK

Seven students were interviewed after completing both the guided-inquiry activity and the scavenger hunt assignment. Institutional review board approval was obtained to conduct these interviews, and all students consented to participate. To protect the students' identities, pseudonyms have been assigned to each research participant. The results of these interviews indicate that students had a positive experience with the guided-inquiry activity and an increased perceived conceptual understanding of snow chemistry processes. Overall, our findings from the interviews triangulate with findings from classroom observations and written artifacts, which are representative of the entire class. When asked how the guided-inquiry activity affected their understanding of concepts from the primary literature article, Cameron said, "I thought it [the guided-inquiry activity] was a lot easier to understand than the original paper." Cameron described how working through the adapted graphs in the models helped them summarize the paper's main points, deepening their understanding of the concepts. Similarly, Taylor described how the guided-inquiry activity supported their interpretation of the text and data in the original article when they said, "I felt like this [guided-inquiry activity] helped explain the bulk of the data. And when I was reading it [the paper], I understood what it was talking about." Finley explained how the models translated the text and detailed figures into graphs that they could understand. They said, "I don't necessarily understand the concept fully when it's just explained in words. I'm definitely a picture learner. So having diagrams [models] is extremely helpful for illustrating the whole point of the paper."

Students also described how this guided-inquiry activity compared to their previous experiences with POGIL activities. Finley recalled their experience with POGIL in high school and said, "When I had to do these in high school, we were given the packet and told to go sit at your desks and just make sure it's done by tomorrow. And questions weren't necessarily asked by the instructor." Finley contrasted their high school experience with this guided-inquiry activity by describing how the instructors purposefully circulated around the room and asked probing questions to each group, ensuring that their

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group's understanding of the models was correct. Active facilitation is an essential component of a guided-inquiry activity that can greatly influence students' perception of the experience. Most of the students also explained how sharing their conclusions with other groups increased their conceptual understanding of the paper. Finley said, "The person that I talked to had a different perspective on one of the questions... I brought that information back to my group. And we kind of talked about it and might have added something [to our guided-inquiry activity]."

Six out of the seven students described how the guided-inquiry activity positively affected their understanding of concepts from the primary literature article. One of the students interviewed, Alex, said that the guided-inquiry activity deepened their understanding of the experimental methods utilized by the authors of the paper but did not contribute to their overall understanding of the paper. After completing both the guided-inquiry activity and the scavenger hunt assignment, Alex could not confidently describe how chloride, sodium, and bromide entered or were distributed within the snowpack. However, the six other students interviewed could describe this concept and use their understanding of the concept to analyze an unaltered figure from the same primary literature source.[24]

Most of the students interviewed explained how the guided-inquiry activity compared to the subsequent scavenger hunt assignment. For example, Blake specified how the guided-inquiry activity was more focused on the paper's content and encouraged development of process skills (e.g., teamwork) and "different ways of looking at the same information", whereas the scavenger hunt focused on the methods and structure of the paper. Riley echoed these ideas by describing how the guided-inquiry activity deepened their conceptual understanding of the results from the primary literature article, while the scavenger hunt allowed them to identify important parts of a paper. Finley described how the scavenger hunt assignment was "helpful in kind of pointing out the structure of the paper" and reflected on their experience with reading the article for the first time: "When I had to read that [article], for the pre-reading, I really just read the information of the paper. And I didn't really pay attention to how it was structured or where the author's names were, or where the acknowledgments were at the end, or any of that really technical stuff." When the guided-inquiry activity and scavenger hunt assignment were used together, students gained greater perceived conceptual understanding of the scientific results than when they read the paper without support prior to the exercise. In addition, they gained perceived understanding of the structure and components of a scientific research article, including how to read and interpret graphs to make sense of scientific results. This perceived understanding of the concepts and structure and components of a scientific research article can lead to higher confidence in research skills,[44,45] as shown previously for this snow chemistry course.[23] This student confidence is a critical factor in persistence in STEM.[44,45]

While the students' perceptions of the guided-inquiry activity were positive overall, there were a few students who had feedback as to how the activity could be improved for future course iterations. Morgan described how some of the guiding questions in the guided-inquiry activity felt redundant: "Some of the questions were a little bit repetitive in each section. And I understand why they [the activity designers] did that. Because it sort of hammers the points home. But also, there were times when it felt like we were just saying the same things slightly differently." Because the models were designed with The Learning Cycle[27,28,30−32] in mind, the guiding questions were scaffolded to build upon students' knowledge. However, future iterations of this activity could combine such questions to reduce redundancy. As mentioned previously, only one group (out of 11) completed all five models within the guided-inquiry activity. While the students were informed that the guided-inquiry activity was not being graded for completion, some students felt pressured to complete the activity nonetheless. Blake provided some insight into these feelings when they said, "I think that maybe a little bit more emphasis on the fact that for the group packet, the time is not as important... because there's points that are going along with this assignment. So some of my group members had a tendency to worry about getting those questions done to get the points, which may have stifled the discussion." Instructors could alleviate this tension by providing more time to complete the activity or reducing the number of models within the activity. Instructors could also implement the scavenger hunt activity as a prelaboratory or homework assignment, thus providing more class time to complete the guided-inquiry activity.

■ CONCLUSIONS

The primary goal of this guided-inquiry activity was to introduce general chemistry students to scientific literature and teach interpretation of graphical data. This activity was implemented as part of a CURE,[23] for students to gain content knowledge of snow chemistry processes that they then applied later in the semester to their research projects. The success of this guided-inquiry activity was partly due to the structure of the activity—that is, we consciously considered what process skills we wanted students to cultivate and developed models that incorporated tenets of The Learning Cycle.[27,28,30−32] Adapting figures from primary scientific literature scaffolded students' perceived understanding of graphical data, as well as snow chemistry concepts relevant to the students' research projects. Instructors actively facilitated students' learning by probing groups with questions to challenge their conceptual understanding and providing students with the opportunity to share their group's conclusions with peers. Through this activity, students engaged in several NGSS science practices, including developing and using models and analyzing and interpreting data, each of which fostered students' conceptual understanding. The guided-inquiry activity described herein, specifically the use of figures adapted from primary literature as models, can be adapted for any introductory or higher-level science course that utilizes primary literature with the goal of gaining skills in understanding and interpreting results presented in this knowledge source. In addition to the implementation in the University of Michigan general chemistry laboratory classroom,[23] an abbreviated version of this activity was incorporated as part of an Arctic snow chemistry research unit that merges local, cultural, and scientific resources in the introductory science classroom at Iḷisaġvik College, a tribal college in Utqiaġvik, AK,[37] highlighting that it can be adapted to other class settings.

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ASSOCIATED CONTENT

Supporting Information

The Supporting Information is available at https://pubs.acs.org/doi/10.1021/acs.jchemed.2c00605.

Snow Chemistry Guided-Inquiry Activity: Figures adapted from the primary literature source and related guided-inquiry questions (PDF)

Research Article Scavenger Hunt Assignment: Questions gauging student understanding of snow chemistry concepts and ability to locate identifying information in primary literature (PDF)

Research Article Prelaboratory Assignment: Three questions to help guide students as they skim the Domine et al.[24] article (PDF)

Instructor Reflections: Full reflections from each of the instructors who facilitated the guided-inquiry activity (PDF)

Post-Guided-Inquiry Interview Protocol: A copy of the semi-structured interview protocol used to interview students after completion of the guided-inquiry activity and scavenger hunt assignment (PDF)

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Notes

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