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Activity

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An Exercise To Coach Students on Literature Searching

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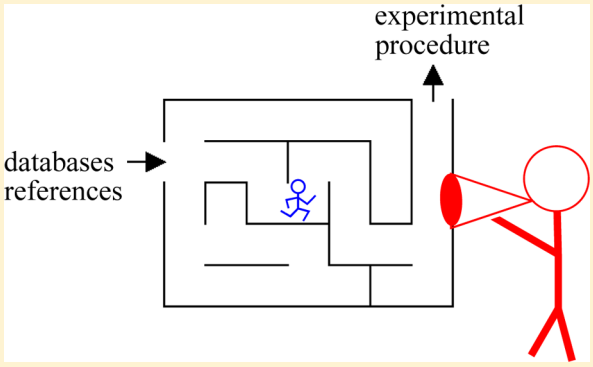
Supporting Information

ABSTRACT: The ability to access chemical literature is an important skill for the developing chemist. Although the College of Saint Benedict and Saint John's University chemistry department had implemented a variety of individual exercises into the introductory course sequence to help students develop literature searching skills, second-year students still struggled with the navigation of the bewildering maze of resources, texts, and databases. This article describes an activity for organic laboratory instructors to coach students on how to prioritize and use a multitude of resources to locate a specific literature procedure. This activity is based on the idea that students find a dialogic approach to be more helpful to consolidate learning and applying knowledge.



KEYWORDS: *Second-Year Undergraduate, Upper-Division Undergraduate, Organic Chemistry, Chemoinformatics, Applications of Chemistry, Reactions*

INTRODUCTION

As described by the American Chemical Society (ACS) Committee on Professional Training (CPT) guidelines, there are many aspects to fully utilize chemical literature;[1] thus, a chemistry curriculum will usually include multiple exercises that require students to practice information skills. Literature searching can be implemented in many ways[2,3] and use a variety of databases or texts.[4−8] With the advent of SciFinder,[9] students have access to a robust and powerful tool, and a number of exercises or models to teach students to utilize SciFinder were published over the past decade.[10−12]

To assess the resources available for instruction in chemoinformatics, the ACS Division of Chemical Information (CINF) regularly surveys departments.[13] Some departments have chosen to implement full courses on this topic,[14−18] while others choose to develop literature skills through a variety of exercises that are relevant to specific contexts. The latter approach involves incorporation into other courses by devoting lectures to the topic, requiring the use of chemical information resources for projects, or merging chemical information principles into laboratory modules.[19−27] According to the survey responses, chemical information is most likely to be incorporated into organic chemistry, inorganic chemistry, or undergraduate chemistry seminar courses; this appears to correlate with the type of exercises found in the chemical education literature. This approach is often a natural fit since students must be savvy about searching the literature to find reference spectra, physical data, reaction procedures, or background information for a research project.

At the College of Saint Benedict and Saint John's University (CSB/SJU), teaching about chemical information is primarily covered in the teaching and research laboratory settings. Students are introduced to a variety of databases and research texts through assignments incorporated into the foundational laboratory sequence. These individual assignments include the use of keyword and structure searching in Scifinder as well as other databases (Supporting Information). None of these assignments are particularly novel as many excellent examples of introducing basic literature skills already were published.[10−12,14−27]

Faculty assumed that students would develop a competency for navigating a range of chemical information resources with the use of individual assignments and, by the second semester of organic chemistry, would be capable of searching the literature to find needed procedures for their independent design of a green project[28] or the development of a three-step synthesis.[29] Yet, even after being introduced to literature searching with specific assignments, CSB/SJU students still struggled with prioritizing and utilizing different databases and reference texts to locate procedures for their design projects. Faculty often spent significant time in office hours directing students to appropriate resources to locate an experimental protocol. A new approach to directing students to the primary literature was needed.

This article describes an approach for laboratory instructors to coach students on navigating a variety of resources to locate a specific experimental procedure from the literature. This particular activity was developed for a second-semester sophomore organic chemistry laboratory.

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■ ACTIVITY

Coaching Approach

This coaching approach was introduced because instructors noticed a "relapse" behavior in students: despite previous exposure to literature searching, when faced with the task of finding experimental protocols, many students relied solely on Google searches. While Google searches are one approach, chemists must become proficient in searching a variety of databases and text resources to locate structures, procedures, and spectral data.

An interactive quiz, wherein the teacher coaches students to consolidate and apply basic literature searching skills, was developed for use in the preparation of students for a subsequent laboratory project. In a dialogic or coaching approach, the teacher can facilitate small group literature searches through discussion and feedback. A recent study indicates that students find this dialogic approach to be more helpful to learn and apply knowledge.[30] Teachers play an important role in classroom or group discourse; to help students consolidate knowledge, connections must be made between ideas and strategies.[31]

Implementation of the Coached Literature Search

The coaching activity is scheduled during a regularly scheduled laboratory period. Students sign up in pairs for 20 min time slots to participate in the coached literature quiz with the laboratory instructor, while the remainder of the class performs a computational modeling experiment. Dry lab experiments are optimal during this time since the instructor is focused on coaching and cannot attend to safety concerns that might arise during a typical experiment.

During the coached searching activity, each student is presented with his or her own description of a specific organic reaction to locate. The description is typically limited to a sentence, for example, "Find a method for reducing a nitro group to an amine using lithium aluminum hydride." A full list of potential research questions can be found in the Supporting Information.

Students have access to a variety of searchable texts and databases during the activity, and the students within a pair are required to search using different approaches to maximize exposure to a variety of sources and the appropriate use of these resources. Another advantage of having students work on the activity simultaneously is that they are also allowed to confer with each other.

Most students must be guided through the "narrowing down" approach of finding a broad category, then identifying the proper subcategory, and so on. A fictional script for coaching the students is provided in the Supporting Information. The immediate feedback provided from the coach or instructor allows them to navigate this interactive quiz rather quickly.

Students are expected to document the steps they take to find a literature procedure that would allow them to run the reaction. By writing down an account of the search, the student is forced to slow down and demonstrate a rational approach. While students attempt the search, the instructor observes the process and may redirect students or field questions as appropriate. Students must find the citation and download the original research article and then show the instructor where the procedure is described in the paper.

Tips for Success

The chemistry laboratory instructors at CSB/SJU found that a few simple preparation steps can improve the success rate on this quiz. The laboratory manual has a list of resources available, and the students have access to guides on accessing the literature through SciFinder and other sources (Supporting Information). A simple reminder to refresh their memories on these tools will often encourage students to look over these guides before the literature search quiz.

When choosing the resources that students have available during the quiz, the coach or instructor should be sure that these databases or texts match the desired information goals. In addition, it is useful to double-check that students will be able to obtain a procedure from a journal readily available through the library to ensure that the activity can be completed within the allotted time.

Grading

The instructor checks in with the students at each stage. For example, the structures involved in the reaction must be verified before the student proceeds with the search, which ensures that the student does not waste time searching in error. The instructor may correct the student at any stage, but deducts points accordingly. A grading rubric (Table 1) is used to evaluate each student's process based on the student documentation during his or her search.

Table 1. Rubric for Literature Searching Activity

activity	points
draw starting material, product, reagent based on description	3
choice of resource	2
describe search terms/approach	3
show search or reference citation	1
describe how to locate procedure after citation	2
list reference citation	2
show instructor the experimental procedure	2

The Question of Relapse

Subsequent to this activity, students were able to navigate the chemical literature to complete the design of their green laboratory project. Laboratory instructors noted a decrease in office visits and fewer protocols printed from online laboratory manuals.

To determine whether our students had retained their knowledge in the field of chemoinformatics, the faculty teaching the upper-division integrated laboratory course in AY 2013−14 assessed students' abilities in two different project laboratories. Of the 22 enrolled students, all of them successfully designed an individual research project using a minimum of three different primary literature procedures. In a second project, pairs of students performed photolysis on an assigned pharmaceutical and developed an high-performance liquid chromatography (HPLC) method to monitor the decay process. For the laboratory report, the students were expected to compare their data to previously reported results in the literature. Eight of the ten groups successfully located a primary literature report on the photolysis of their specific pharmaceutical; they also independently obtained this data before the laboratory experiment, instead of later when they were writing their report. This group of students developed a fluency in chemical information retrieval. Although this outcome cannot directly be attributed to one exercise, the interactive quiz gives

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students an opportunity to refine literature searching skills with immediate expert feedback.

SUMMARY

It is incumbent on chemistry departments to provide students with pertinent and modern opportunities to become not only information competent, but also information fluent. This coaching activity plays a key role in the development of chemical information skills in our curriculum. The CSB/SJU chemistry department has used this approach in the sophomore organic chemistry laboratory; however, we have also modified it to be used in a foundation level synthesis laboratory. The coaching exercise described here could readily be adapted to a variety of settings.

ASSOCIATED CONTENT

Supporting Information

Previous literature searching assignments, student handout, coached assignment and grading rubric, sample quiz topics, and a fictionalized coaching script. This material is available free of charge via the Internet at http://pubs.acs.org.

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Notes

The authors declare no competing financial interest.

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