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- Using guided inquiry-based activities in 2-year colleges
- Analyzing student evaluations on RateMyProfessors.com

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FEATURES

DEPARTMENTS

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A Short, Course-Based Research Module Provides Metacognitive Benefits in the Form of More Sophisticated Problem Solving

By Caroline L. Dahlberg, Benjamin L. Wiggins, Suzanne R. Lee, David S. Leaf, Leah S. Lily, Hannah Jordt, and Tiara J. Johnson

Reflection and recalibration, two key hallmarks of metacognition, are important elements of productive problem solving in scientific research. Often, training in these skills is obtained informally through direct exposure to independent research after college. Although some undergraduate students participate in extra- or co-curricular research experiences, many cannot. Course-based undergraduate research experiences are therefore a more accessible way to engage students in research. However, formal training in problem solving is not always included in such experiences and introducing research experiences to large numbers of students can be logistically challenging. Here we show that a short, course-based research module that provides metacognitive training in a high-enrollment biology course enhances complexity of student responses to a research-related problem-solving exercise. Students did not self-report changes in problem-solving abilities or approaches on a Likert-scale survey; however, in focus-group interviews students did describe how design and implementation enhanced their engagement and investment in the research experience. These data support the idea that even short research modules can provide measurable benefits to students and may be an alternative to more costly whole-course research experiences.

Although completion of an undergraduate degree in STEM (science, technology, engineering, and mathematics) can take more than 5 years, there is no guarantee that STEM graduates will encounter courses that directly facilitate the development of problem-solving and research skills that are expected of professionals with degrees in STEM fields (President's Council of Advisors on Science and Technology, 2012). In part, this is because traditional STEM courses often prioritize memorization of factual content and proper execution of lab techniques, rather than helping students to build skills that enable creative and constructive problem solving (American Association for the Advancement of Science, 2011; Brownell, Freeman, Wenderoth, & Crowe, 2014; Hoskinson, Caballero, & Knight, 2013; Lawson, Banks, & Logvin, 2007). One important problem-solving skill is the ability to use metacognition to self-reflect and recalibrate one's actions. In scientific research, metacognition is regularly used through the process of choosing a research question, designing hypotheses, and running and analyzing experiments (Tanner, 2012). Despite its importance, metacognition is often implicitly conveyed, rather than directly taught, through extended apprenticeships in a research setting or graduate school (Schwartz, Tsang, & Blair, 2016).

At the undergraduate level, students can acquire research experience by participating in research projects led by science faculty or by participating in course-based undergraduate research experiences (CUREs; Kloser, Brownell, Chiariello, & Fukami, 2011; Lopatto, 2007). Faculty-led research in a laboratory is beneficial to students' identities as scientists and often leads to interest in further scientific education (Brownell & Kloser, 2015; Gregerman, Lerner, von Hippel, Jonides, & Nagda, 1998; Russell, Hancock, & McCullough, 2007). However, independent research experiences are unavailable to many students due to a number of factors, including limited faculty laboratory space, funding, and mentoring time; limited student time; and the challenges of navigating academic hierarchy to find research opportunities. The latter two impediments are most salient for students from traditionally underserved populations and first-generation college students (Kuh, 2008). To mitigate these barriers, many undergraduate institutions work to bring research into their curriculum through CUREs (Brownell & Kloser, 2015; Hurtado, Cabrera, Lin, Arellano, & Espinosa, 2008; Kloser et al., 2011; Wei & Woodin, 2011). Although implemented over shorter time scales, CUREs typically incorporate several aspects of independent research, including investigation of the unknown. Students benefit from their CUREs by building stronger identities as scientists and by connect-

Arriving at a Better Answer: A Decision Matrix for Science Lab Course Format

By Emily K. Faulconer, Laura S. Faulconer, and James R. Hanamean

At first glance, scientific laboratory experiences might appear to be challenging to move to the cloud. Skeptics may point to sensory feedback limitations and inequivalence of student outcomes. However, emerging data increasingly provide evidence that scientific laboratory courses are not only amenable to online learning, but also can deliver student outcomes at or above traditional in-person courses. In identifying a science lab format, each institution weighs factors like lab course goals, budget, program growth, access, and safety. This article presents a single case study and a decision matrix for how one institution informed their choice for the modality of a chemistry lab course. There is no right answer for a lab modality, but the decision matrix allows for selection of the best-fit modality based on institutional parameters.

When nontraditional (online) and traditional (face-to-face) courses are pitted against each other, the general consensus is that nontraditional modalities produce equal or better student outcomes (Allen & Seaman, 2013; Bernard et al., 2004; Cavanaugh, Gillan, Kromrey, Hess, & Blomeyer, 2004; Nguyen, 2015; Xu & Jaggars, 2013). Some types of learning settings tend to be viewed as impossible or very difficult to move to an online learning format, and this includes laboratory courses. In addition to the traditional hands-on laboratory experience, lab courses are now being offered online (simulation based), as virtual reality, and using mail-order lab kits (Faulconer, Griffith, Wood, Acharyya, & Roberts, 2018; Faulconer & Gruss, 2018; Gould, 2014; Pienta, 2013).

Most comparisons of science lab modality in the literature focus on a single experiment or unit. However, several recent whole-course studies have shown that many student outcomes are achieved at equal or greater frequency in nontraditional labs than traditional labs (Biel & Brame, 2016; Brinson, 2015; Faulconer et al., 2018). Understandably, best practices would include monitoring student learning outcomes in the rollout of a major course change. However, the course format decision process does not need to center on comparable student outcomes (acknowledging the data for these comparable outcomes is influenced by variables like pedagogical methods) when considering the ideal laboratory experience for students. Instead, an institution might seek answers to several important questions:

- What is the primary purpose of the laboratory experience (teaching laboratory skills or reinforcing lecture content)?
- What are the budget constraints?
- What is the targeted rate of program growth and the infrastructure capacity?
- What are acceptable safety and access parameters?

Decision matrix for selecting lab format at ERAU

At Embry-Riddle Aeronautical University (ERAU), a best-fit decision was reached as these very questions were weighed. The decision was made around institution-level criteria, not classroom-level ones, like the pedagogical approach. The introductory general chemistry laboratory courses had been taught at two traditional campuses (using traditional face-to-face labs), whereas the online campus had used laboratory simulations. A decision matrix was used to arrive at the ideal lab format for ERAU students taking the lab course through distance education (Table 1). The first step was to rank the importance of the five key criteria: skills teaching, budget, infrastructure capacity, accessibility, and safety. A criterion ranking of 1 indicated a less important criterion and 5 indicated a very important criterion.

As with the ranking of the impor-

What's Important: An Exploratory Analysis of Student Evaluations About Physics Professors on RateMyProfessors.com

By Mihwa Park

This study explored students' evaluations of their introductory physics professors posted on RateMyProfessors.com. Data included 1,521 student written comments along with numerical ratings. Student-written comments were sorted into three groups based on their numerical ratings: good, average, and poor quality. Using a text-mining technique, categories representing themes from student comments were developed, and category frequencies were investigated to compare student comments across the three groups. A decision tree model was also used to see what categories were significantly attributed to the different groups. The results showed that students were sensitive to professors' classroom practices and a coherence between requirements and lectures. Also, professors' positive attitudes toward students were in play as an important attribute for more positive evaluations.

Most colleges use formal evaluation forms for students to evaluate their professors at the end of the semester. Although students have this opportunity, results are not generally made available to students and the public, whereas RateMyProfessors.com (RMP), the largest online professor review website, allows students to anonymously rate their professors with great freedom with their ratings and commentaries open to the public so that others may obtain information about their future courses easily without any extra steps such as logging in or requesting information.

When students attempt to rate their professors on RMP, they are asked to provide a rating in numeric form and to provide written commentary about their professors. Regarding numerical ratings, RMP asks two questions, "Rate Your Professor" and "Level of Difficulty," and students rate their professors with scales from 1 to 5. RMP also asks three simple "Yes" or "No" questions such as "Would you take this prof again," "Was this class taken for credit," and "Textbook use." As such, the numerical ratings do not provide much information about courses or professors. Consequently, students rely more on the open-ended comments over the numerical ratings and consider the comments to be more informative (Kindred & Mohammed, 2005).

Athough the RMP found fame as a new platform for evaluating professors, there may be disagreement about whether student evaluations on RMP provide credible messages. Indeed, studies have shown mixed findings on the validity of student evaluations on RMP. Some studies have found that ratings on RMP were not different from those on formal evaluations of teaching (Coladarci & Kornfield, 2007; Timmerman, 2008; Villalta-Cerdas, McKeny, Gatlin, & Sandi-Urena, 2015). Otto, Sanford, and Ross (2008) concluded that ratings on RMP were not a biased measure of student learning, but rather may reflect honest assessments of professors, whereas some studies showed that ratings on RMP were invalid for assessing teaching effectiveness (Clayson, 2014; Davison & Price, 2009). It is possible that RMP provides biased evaluations; however, the question of validity of student evaluations on teaching has been raised for formal evaluations as well (Kember & Wong, 2000).

RMP should not be a substitute for formal evaluations; however, many students consider students' ratings as a credible source of information about their future courses (Brown, Baillie, & Fraser, 2009; Kowai-Bell, Guadagno, Little, Preiss, & Hensley, 2011; Li & Wang, 2013) and trusted them when making course selections (Davison & Price, 2009). Furthermore, RMP's popularity has been