



Opportunities and Challenges of Online Instruction and Effective Pedagogy That Blurs the Lines between Online and On-Site Teaching and Learning

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INTRODUCTION

There has been an increased focus on online teaching as the COVID-19 pandemic continues. While online teaching is certainly not a new mode of education, it has been further developed and analyzed in current times, as most instructors were required to incorporate novel and effective methods for remote instruction. At the same time, these instructors sought to evaluate the inclusivity and effectiveness of such practices to ensure that students not only learned during their online courses but continued to receive the support needed to overcome systemic biases and stressors. The 2022 themed issue, “Opportunities and Challenges of Online Instruction: Blurring the Lines Between Online and On-Site Teaching and Learning,” focuses on key topics that are most pertinent to online education, the wealth of practices used to facilitate such an approach to teaching, and how these methods can continue to be used as effective pedagogical tools as we strive to improve both remote instruction and the return to in-person teaching.

A previous *JMBE* themed issue on “Teaching in a Time of Crisis,” released during the height of the pandemic in 2021, focused, by necessity, on the rapid switch to online education prompted by the emergence of COVID-19. The articles in that issue reported on the experiences of educators and students

during this switch to emergency remote instruction and the challenges brought about by the rapid change. At that point, many faculty members had never taught online before, and for some, the learning curve was very steep, but ultimately successful.

As we emerge from the pandemic and look back on the remote instruction that occurred over the past two years, analysis has shown that online education is accessible, flexible, and effective. As educators, we must recognize that now is the time to build on the progress made during the pandemic in fostering a culture of remote instruction in higher education and, where applicable, in K-12 pathways. This issue highlights for all of us the fact that pedagogies incorporating online education, in its many modalities, are the future. As an editorial team, we identified five main themes addressed by the articles included in this themed issue, each of which is discussed below.

ADDRESSING STUDENT ANXIETY AND STRESS

Propelled by new technologies and a growing range of learners, online instruction has led to changes in pedagogy and creative innovations. Authors in this issue shared findings from studies that addressed student perceptions of stress in online biology courses (1), described opportunities to maximize academic integrity while reducing stress in virtual environments (2), and explored student anxiety and engagement in online instruction (3, 4). Articles in this issue also report on student preferences for individual and group work in virtual classrooms, which will help inform assignment design and teamwork guidelines (5, 6). Engaging all students in effective study habits, through open discussion of access needs, helps to build inclusive and antiracist curricula. Thus, new knowledge that aids in the use of study techniques and universal designs for learning can help all instructors improve how they support students.

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CONFRONTING ISSUES OF DIVERSITY, EQUITY, INCLUSION, AND JUSTICE

COVID-19 pandemic-related stress, aggravated by the racially driven, violent events of Spring 2020, prompted a nationwide movement among instructors to mindfully integrate principles of antiracism, justice, equity, diversity, and inclusion in their pedagogical activities and courses. This overarching theme was evident in several articles of the current themed issue. One perspective included in this issue described an instructor community of practice-led approach to developing antiracist, just, equitable, diverse, and inclusive (AJEDI) principles for integration into the online modules associated with course-based undergraduate research experiences (CUREs) (7). In another perspective, the authors identified the unique challenges faced by online learners and provided recommendations for mitigating them (8). The author-led investigations included those that examined the extent of challenges faced by students with disabilities in an online environment (9) and how students representing diverse racial, gender, and residential backgrounds were differentially affected by worries and stress related to viral contraction or food insecurity (10, 11). The issue also described a perspective-taking classroom activity that aims to address racial bias by having students explore intelligence as a biological trait (12). Another activity described a method of using student-created research avatars during video conferencing to help reduce concerns associated with the use of cameras (13). All in all, these studies present many methods that can be used by instructors to intentionally address issues related to diversity, equity, inclusion, and justice in the classroom, support our students, and ultimately help promote retention and belongingness.

PROMOTION OF STEM BELONGINGNESS, ENGAGEMENT, AND IDENTITY

STEM belongingness, engagement and identity are important aspects of science courses. Investigations related to such aspects, specific to online instruction, represent a significant theme in this issue. Authors investigated methods for using technology to create an inclusive and collaborative scientific community during remote instruction and allow students to truly see themselves as scientists (14). Other manuscripts explored student preferences for learning and interaction during remote instruction and how to include student-directed lines of inquiry in both lecture and research courses (15). Taken together, such manuscripts help to develop mechanisms by which students become part of a more global scientific community through their online and blended coursework.

ONLINE OR HYBRID LABS AND CLASSROOM ACTIVITIES

An important focal point of this issue is remote instruction for laboratory science courses. Previously dismissed as ineffective

and not transferable, online and hybrid lab courses were forced onto students during the pandemic. They (and the education community as a whole) quickly realized, and the data bore out, that these learning tools were cost-effective and engaging, and led to robust learning gains. In this issue, several manuscripts presented methods that can be used to effectively create online or hybrid labs (16, 17), including labs that can be performed at home by students (18, 19), how to create effective simulations of laboratory activities (20, 21), and how to teach students about laboratory safety outside of the lab (22). Other studies reported on how to keep students engaged in wet-lab activities performed virtually (23), how to teach microscopy remotely (24), and how to implement training in quantitative skills into online courses (25). Both instructor and student experiences were reported, providing important context for the efficacy of these courses and their reception by students. The breadth of papers related to implementing online and hybrid labs shows the importance of this topic; we hope that they help you to implement remote lab learning into your courses no matter the modality with which they are delivered.

In addition to laboratory-specific activities, many other in-person activities which made classroom learning effective and engaging were forced to change in response to the COVID pandemic. Instructors were required to greatly alter how they taught when they moved to emergency online instruction, and many tried-and-true methods of active instruction had to be altered to fit an online paradigm. Instructors who made these changes realized that the current state of technology allows for high-quality adaptation of many activities and instructional materials to remote instruction methods, and that these changes can continue to be useful in largely in-person teaching as well (26). In this issue, one article described methods by which students can create virtual “escape rooms” to promote learning in an ecology classroom (27). Another described a toolbox of virtual biology teaching tools that can be used to create an exciting and engaging biology classroom, whether virtual, hybrid, or in-person (28). We hope that these tools and activities, like the lab activities described above, will be useful to many in designing their own biology courses.

DEVELOPING SCIENTIFIC COMMUNICATION SKILLS REMOTELY AND WITH SOCIAL MEDIA

The social distancing required by the COVID-19 pandemic and the subsequent switch to online learning made communication, both with and between students, difficult. However, effective communication is important for engaging students and contributes to their wellbeing, so creating and maintaining effective lines of communication is vital for creating an effective remote classroom (29). In addition to communication for classroom activities, developing scientific communication skills is an important part of a STEM education. Authors in this issue described using several methods to encourage classroom communication and allow students to practice disseminating scientific information, including the use of social media platforms (30) such as Twitter (31),

TikTok (32), and Discord (33). Multiple authors also described methods for developing their students' scientific communication skills by creating online or hybrid poster sessions that allowed students to practice communication skills in an inclusive manner (34, 35). These papers provide several methods that all educators can use to encourage student communication and allow them to practice presenting complex scientific information, and to provide an excellent launching board for any instructor attempting to promote these goals.

FINAL THOUGHTS FROM THE EDITORS

The COVID-19 pandemic has affected teachers and learners at all institutions. As in-person teaching resumes, remote teaching persists, and classrooms assume an air of normalcy, there is a temptation to simply return to teaching using the tried-and-true methods used prior to the switch to emergency remote teaching. However, doing so, forgetting the lessons learned in developing effective online pedagogy, would be a mistake. Instead, we must use this knowledge to create superior in-person classroom experiences augmented by the best remote teaching methods available. In courses that continue to be entirely remote, which can reach many important and otherwise underserved populations, these same lessons can form a basis for creating high-quality online courses that effectively and flexibly transmit STEM knowledge to as many students as possible. All told, we hope that the papers presented in this issue provide you with ways to create an effective, inclusive classroom environment, along with convincing data related to the effectiveness of such methods.

We thank all the authors who submitted articles to this themed issue and reported on their experiences and new knowledge. We also thank all the reviewers who worked hard to ensure that all the papers that were submitted received a fair evaluation and that all those that have been accepted are of the highest possible quality. Everyone involved in creating this issue, from the instructors who designed and implemented novel activities and the students who participated in the classes, to the authors, reviewers, and editors who developed and improved the final papers, have worked hard and deserve to be recognized for their contributions to realizing the best practices of online, hybrid, and in-person pedagogy.

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