INTRODUCTION

As trained scientists, we become adept not only at analyzing and understanding figures in the scientific literature, but also at designing figures to effectively represent our own data and findings. As educators, we strive to pass on these skills to our students, some of whom will ultimately become scientists themselves. Conveying the principles of effective figure design can be challenging, particularly when students have had little exposure to the process of reading scientific literature, much less writing a piece of scientific literature.

Improvisational activities in the classroom reinforce teaching goals such as spontaneity, risk-taking, creativity, communication skills, team-building, and critical thinking (2). Indeed, improv training for scientists is becoming more common, helping scientists to communicate more spontaneously about their work and connect with their audience (1). In this article, we present an improvisational game that can aid in the teaching of effective scientific figure design. This “Present-a-Fake-Figure Exercise” is applicable to both the classroom and laboratory settings. In this learning activity, students improvise presenting fake scientific figures to an audience of their peers. These fake figures are prepared beforehand by the instructor and exemplify the do’s and don’ts of scientific figure design. Some of the learning outcomes of the activity include (1) identifying what makes a scientific figure cohesive, easy to analyze, and reader-friendly, and (2) identifying strategies that are useful in the design of a multi-panel figure to convey a scientific story.

PROCEDURE

This exercise was first adopted for the purpose of entertainment and community building during the annual retreat for the Department of Molecular Pharmacology at the University of Miami (Miami, FL) (Fig. 1). The exercise was subsequently adapted for the classroom setting by S. Walsh. The experiences described below are from work done by junior/senior-level students in S. Walsh’s cell biology and senior seminar classes at Rollins College (Winter Park, FL), and by graduate students in S. Pulford’s advanced English as a Second Language (ESL) academic writing class at UC Davis Extension (Davis, CA).

The instructor constructed a variety of PowerPoint slides, each containing a fake scientific figure with at least two panels of data (Supplemental Figures 1 and 2). For the cell biology students, the panels depicted familiar experimental techniques and data formats, such as immunoblotting, immunofluorescence, enzyme kinetics, chemical structures, or other graphical data, although the specific data set was unfamiliar (Supplemental Figure 1). For the ESL students, the panels depicted general data representations such as maps, bar graphs, network diagrams, and technical illustrations (Supplemental Figure 2). Both figure sets included slides with additional challenges such as unrelated panels that were more difficult to weave into a storyline. Likewise, some figures had strategically placed labels on
the figures while some did not, making them harder to understand and present. The data and diagrams used for each of the panels in the fake figures were obtained from a variety of sources including primary literature, textbooks, Google Images, the Cell Signaling Technology website (www.cellsignal.com), and unpublished laboratory data. In addition, resources like MicrobeLibrary (http://www.microbelibrary.org/) and The Cell: An Image Library (https://www.cellimagelibrary.org/) are great sources of images for this purpose. When appropriate, the images or data used in the fake figures were stripped of descriptive labels.

Volunteer students were recruited to improvise presenting these figures in two minutes or less. No preparation time was provided. Each student's task during the two minutes was to explain the fake figure to his or her classmates and to give the figure a title. Students were then invited to create a fake figure for the instructor to present by drawing on the board or composing in PowerPoint. The instructor left the room while the students crafted this fake figure. After approximately five minutes, the instructor returned to present the figure, following the same guidelines given to the students.

Following the activity, students provided a written or oral reflection on their experience by answering the following questions: (1) What made this exercise difficult? (2) What did you learn is important in a good figure? (3) Other comments? (See Supplemental Table 1 for student responses.) In general, the comments from the graduate students in S. Pulford's class were more specific and elaborate than those from the undergraduate students in S. Walsh's classes. This may speak to the graduate students' more extensive experience with primary scientific literature, or simply to the distinct atmosphere of the courses in terms of expectations for this activity.

The class then discussed some of the characteristics of effective scientific figures, such as the appropriate use of labels, arrows, trend lines, and headings (3, 4). Students critiqued the fake figures and discussed what would have made them more cohesive, clearer, or easier to present. In creating their own hand-drawn figure for the instructor, students realized that they had provided significant detail, such as axis labels on graphs, that may have been missing on the fake figures provided to them.

The exercise was intentionally carried out in classes composed of upperclassmen and graduate students, as they had more familiarity reading scientific literature, understanding the techniques, and presenting their work using PowerPoint slides. The experience may have been more challenging for freshmen or sophomores just beginning to critically read and comprehend scientific data.

CONCLUSION

This exercise allows students not only to practice their figure design skills, but also to critique a scientific figure and to identify ways to improve its design. It brings to life the idea that a scientific figure is easiest to understand and clearest when it tells a story, with each of the panels contributing part of this story. At the same time, it illustrates the fact that a scientific figure that is not designed with the reader in mind and not equipped with strategically placed captions or labels might fail to tell the intended story.

The activity also allows students to practice their presentation skills in a low-stakes environment so that in the future, they will be more comfortable presenting their own work at conferences and scientific seminars. By integrating improvisation into the classroom, students learn to “think on their feet,” which may enable them to process information and answer questions more quickly, another key aspect of effective public speaking in the sciences. Students simultaneously strengthen some of the skills needed for success in the classroom, such as extracting information from figures in textbooks, lecture presentations, and scientific literature.

Another benefit of the improv format is that the presenter must try to understand a figure quickly, similar to what the reader experiences when reading a scientific paper. By making the reader's meaning-making process public, this exercise enables the entire class to see how a reader gathers information from a figure. This, in turn, illustrates the importance of aligning a reader's construction of a story with the author's storytelling.

The “Present-a-Fake-Figure Exercise” accomplishes these learning outcomes while generating a unique and memorable shared class experience that leads to team-building and comic relief from the everyday academic grind. Overall, students who completed the exercise realized the importance of labeling and coherent storytelling in the context of a low-stress, fun activity.

SUPPLEMENTAL MATERIALS

Supplemental Figure 1: Examples of presentation slides containing fake figures
Supplemental Figure 2: Additional examples of presentation slides containing fake figures
Supplemental Table 1: Student responses to reflection questions

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