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CUR Focus

Engaging Students in Ethical Considerations of the Scientific Process Using a Simulated Funding Panel

All undergraduates majoring in a physical or natural science in the College of Arts and Sciences at Florida Gulf Coast University (FGCU) are required to take an interdisciplinary-science methods course entitled Scientific Process. This course is designed to help professionalize students by introducing them to the history, practice, philosophy, and ethics associated with being a working scientist (Meers, Demers and Savarese 2003). Most students take the course early in their junior year as the first class in a sequence of research courses that culminates in conducting and presenting independent research during their senior year.

Scientific Process is typically delivered in a discussion format with two instructors from different scientific disciplines bringing their individual expertise to the course content. Presently, two to five sections of the course are taught each fall and spring semester; summer sessions tend to offer a single section of the course. More than 1,900 students have completed the course since the university opened in 1997.

Students' creation of a research proposal, where he or she demonstrates an ability to apply concepts covered in the course, is the primary assignment in Scientific Process. A student's proposal is a semester-long writing assignment that is modeled after the National Science Foundation's proposal requirements (e.g., NSF 2014). To complete the exercise, students must identify a research interest, review the relevant scientific literature, develop a focused research topic, design appropriate research methods, and then write a proposal for the study. Peer groups modeled on Chalmers "scientific communities" (1976) are formed early in the semester among students who share similar interests within the same section of the course. Students in the peer groups meet regularly in class to review and edit components of each other's proposals. These informal peer-review sessions help students refine their writing ability, critical thinking, and information literacy. In particular, they emphasize the need for students to communicate complex scientific concepts in a clear and precise manner, while being mindful of the author's audience. Students also experience the iterative process of edits and revisions that is integral to successful scientific communication and scholarship.

Scientific ethics are examined throughout the course, including a specific module near the end of the term that addresses overarching ethical considerations. Students learn how to engage the primary literature ethically, including the proper use of citations in the development of their research proposal. Students are also introduced to the scientific review boards that govern the study of humans (Institutional Review Board; IRB) and vertebrates (Institutional Animal Care and Use Committee; IACUC) in the United States. Each semester a representative from these groups presents an overview of each committee's role and functions. While students are not required to submit an IRB or IACUC application with their proposal, they must indicate whether one would be needed in actual research. During the module about ethics in science, students read and engage in class discussions that focus on a number of ethical considerations that scientists confront, including issues of fraud, financial conflict of interests, and scientific misconduct.

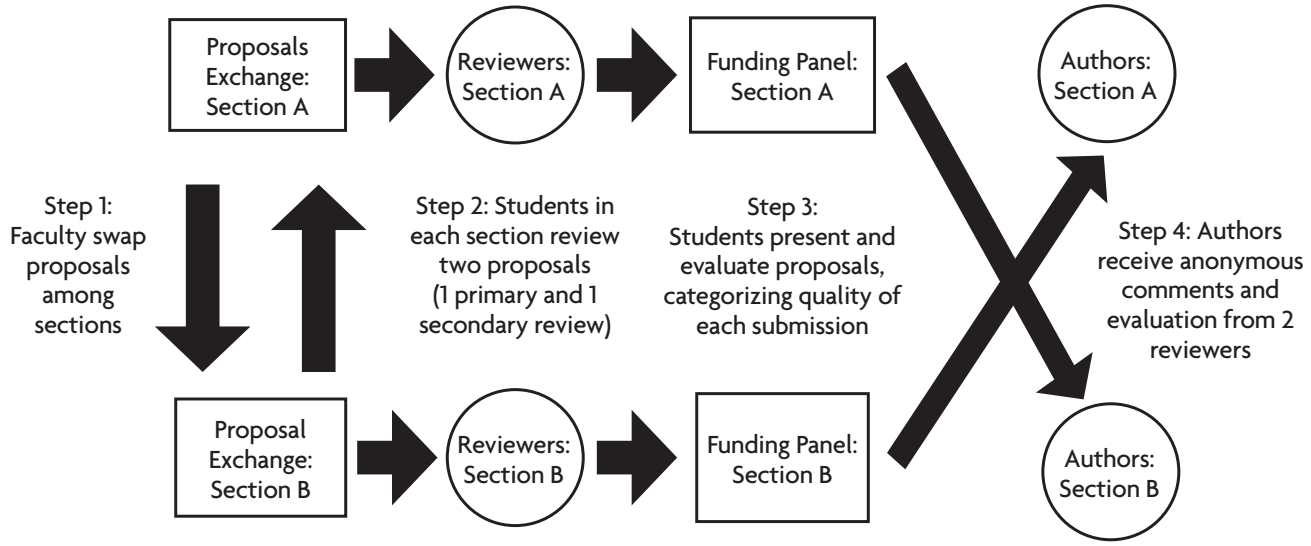
Simulating a Funding Panel

In 2010, faculty members teaching Scientific Process added a new component—a simulated funding panel. The goal of this activity was to enhance written proposals and improve peer reviews by the closing the loop on the proposal phase of scientific research. In this simulation, students conducted a formalized peer review of proposals from another co-occurring section of the course. The simulation occurred only after students underwent five to six editing sessions of their research proposals by their peer groups, which allowed them to better distinguish high- and low-quality proposals.

Substantial coordination among faculty members was then required to arrange reciprocal exchanges of student proposals across the concurrent sections of the course (Figure 1). Students were given access to all the research proposals that their section would evaluate via the learning management system. However, each student was only responsible for reviewing two proposals, serving as the primary reviewer for one and the secondary reviewer for the other. This resulted in all proposals receiving two independent reviews. Faculty members tried to match the subjects of the proposals that a student would review with that student's field (e.g., chemistry majors reviewed chemistry proposals). In addition, the process was conducted in a double-blind fashion, so that both authors and reviewers were anonymous.

The student reviewers were required to write a short summary of the two assigned proposals prior to the simulated funding

Figure 1. Logistic Plan for Funding Panel Simulation



panel, which could last as long two class meetings, depending on the number of proposals. During the meeting, each primary reviewer was allotted five minutes to present his/her summary, which highlighted the research focus of the proposal and outlined its major strengths and weaknesses. The secondary reviewer could then provide additional insights and clarifications that could either support or contradict the assessment of the primary reviewer. Then, the funding panel as a whole scored each proposal on four categories: not fundable (i.e., poor), fundable after major revisions (i.e., OK), fundable after minor revisions (i.e., good), and readily fundable (i.e., excellent). The top three proposals were forwarded to the faculty members in the section whose students produced the proposals for a final evaluation. Each meeting of the simulated funding panel was student-driven; the teaching faculty's role was to facilitate, but not direct, the meeting.

After completion of the simulated funding panel, each proposal's author received anonymous comments from both the primary and secondary reviewers and the "funding" decision made by the class section of students who reviewed the proposal. At the discretion of the course faculty, students who submitted one of the three highest ranked proposals in their class section received a "funding award." Students who received funding earned an "A" for the assignment and were not required to revise and resubmit a final version of their research proposal. All other students had to revise and resubmit their research proposals based on feedback received from the funding panel.

The funding-panel simulation described above has developed over time as faculty reflected on the experience. In addition, the simulation has been adjusted based on class size and the number of course sections offered during a semester. For example, the first iteration of the simulation did not include a double-blind review: student authors and student reviewers could identify each other. In addition, students in summer sessions (when only one section of the course was taught) exchanged proposals after the class was split into half so that the activity could include double-blind reviews.

Students in "Scientific Process" class evaluating proposals in a simulated funding panel (from left to right, Giana Barese, Stephen La Touche, Hugo Drago Jr., Lauren Tierney, and Sunni Whobrey)

Ethical Insights

The simulated funding panel was developed because it extended students' proposal-writing process to its natural and realistic conclusion. However, the rewards and challenges we faced in implementing the activity took the experience beyond our original intent. During the simulation, students had an opportunity to take an "outside look" at the peer-review process, which helped them discover many ethical considerations that scientists must grapple with in the real world, including issues of anonymity, bias, preparation, and civil discourse (Souder 2011).

Exploration of these ethical insights began with an anonymous survey that students completed after the funding-panel simulation. In the survey, students used a five-point Likert scale to indicate their agreement or disagreement with statements about the value of the experience and the effect of the experience on their writing and scientific understanding. With the exception of one statement concerning anonymity, the survey statements did not address ethical issues associated with the peer-review process.

Overall, students found the experience rewarding (Table 1). The vast majority of students (89.5 percent) strongly or somewhat agreed that the experience was valuable. Students also believed that they learned more about writing and the scientific process from participating in the simulation (83.1 percent and 69.6 percent, respectively, strongly or somewhat agreed). In addition, students felt that they reviewed proposals about subjects that aligned with their own interest (61.8 percent strongly or somewhat agreed), and students thought that they were well prepared, having read their two assigned proposals carefully (93.3 percent strongly or somewhat agreed). Finally, a minority of students thought that the experience would have been different if names of the author and reviewer were unknown (36.6 percent strongly or somewhat agreed).

Students also had the opportunity to explain their thoughts in one- to two-sentence free responses after each question (Table 2). These responses were analyzed using a grounded theory approach that allowed patterns pertaining to ethical implications to emerge without a priori hypotheses (Glaser and Strauss 1967). The most frequent student comments described improved learning, writing, and critical thinking (N = 107) and increased understanding of the peer-review process and grantsmanship (N = 96). Students also identified ethical considerations associated with the peer-review process, including concerns about anonymity and associated bias (N = 59); complications related to reading a limited sample of submissions (N = 35) or incomplete preparation/training (N = 27); and problems emerging from a lack of civility (N = 13). Students then engaged in a post-funding panel discussion, in which they had the opportunity to reflect on ethical matters and implications associated with the peer-review process. Faculty corroborated student-identified ethical implications from the survey during these post-simulation class discussions.

The lack of anonymity in the peer-review process was the most common concern that students expressed. Students described problems associated with transparency that occurred because the simulated funding panels took place among concurrent sections of the course; some reviewers determined the identity of student authors even though efforts were frequently made to create double-blind reviews. For example, one student described the difficulty reviewing someone whom he or she knew: "I knew the author of one of my reviews well and it definitely changed my thought process."

Table 1. Summary of Student Responses (%) to the Funding Panel Simulation

Statement	N	Strongly Disagree	Somewhat Disagree	Neither Agree or Disagree	Somewhat Agree	Strongly Agree
The funding panel was a valuable learning experience.	238	0.8	2.1	7.6	52.9	36.6
I learned more about writing an effective proposal by participating in the funding panel.	237	1.3	2.5	13.1	53.6	29.5
I learned more about the process of science by participating in the funding panel.	237	1.3	6.3	22.8	47.2	22.4
The subject of the proposal I reviewed was similar to my research interests.	238	7.2	15.1	15.9	43.3	18.6
I was well prepared for the panel; I carefully read both of my proposals.	237	0.4	1.7	4.6	35.3	58.0
The process/experience would have been different if the name of the person you were reviewing was unknown – that is, if both the reviewer and reviewee were anonymous.	238	8.0	34.5	21.0	22.3	14.3

Table 2. Students' Most Frequently Cited Insights, Suggestions, or Criticisms Regarding the Funding Panel Simulation

Described improved learning, writing, and/or critical thinking (N = 107)
Identified increased understanding about the peer review process and granting in science (N = 96)
Expressed unease about the potential lack of anonymity and/or associated bias (N = 59)
Wanted to be able to read more or all proposals (N = 35)
Described a positive, non-specific experience (N = 32)
Requested additional training before conducting a funding panel (N = 32)
Needed more time or better preparation prior to the funding panel simulation (N = 27)
Voiced alarm about minimal effort observed in some submissions or funding panel participants (N = 19)
Stated concern about the civil discourse of the peer review process (N = 17)
Desired a better alignment between their interests and/or knowledge and their reviewed proposal (N = 13)

Note: 200 of 238 students wrote at least one comment in the post-funding panel survey.

This transparency seemed to create cooperative conditions among some reviewers and student authors as evidenced by one reviewer who wrote, "It was hard to know that we were judging our friends and [we] may have felt pressured not to be harsh [because] we're all peers." Other students noted that transparency could actually lead to harsher reviews. For example, one student reviewer wrote, "It is tempting to look up people we are reviewing on Facebook. I might have graded more harshly/meanly." This student also illustrated how a few reviewers used social media to learn about the student authors.

Students also identified specific biases. Many examples of bias were ad hominem arguments (Souder 2011) that actually appeared to benefit, instead of harm, student authors. Some reviewers described sensitivity to student authors who seemed to have learned English as a second language. For example, said one reviewer, "The paper appeared [to be] written by an author where English was potentially not [his or her first] language. Seeing a foreign name made me be gentle in the delivery of recommendations." Other reviewers mentioned a gender bias, with one saying, "The only bias is that I am slightly more partial to females." Students also identified an age bias that is typically found in many academic institutions and disciplines. Just as some funders provide advantages to junior faculty members and researchers, including for example, the National Science Foundation's Faculty Early Career Development (CAREER) Program and the National Institute of Health's Pathway to Independence Awards, students recognized a need to accommodate lower-level authors, as evidenced by one student who wrote, "I did feel like I rated the sophomore proposal lighter than the junior."

Because the value or importance of the proposed research is key to a successful proposal, having disciplinary experts review the work helps assure that proposals are reviewed and judged fairly. Just as scientists do not feel qualified and are sometimes reluctant to review and make recommendations on work outside of their expertise (Lee 2006), our students felt that their lack of preparation prevented them from fairly reviewing proposals that were not similar to their own backgrounds. As one student said, "only the topics the reviewer is familiar with should be graded by the review[er]." Other students described the perceived subjectivity associated with the incomplete peer-review process, in which each student reviewed only two proposals. Said one student, "We basically just pick the paper we liked best, we didn't have time to break it down nor truly decide because I didn't even read the one we funded so it was a group vote that was bias[ed] based on readers[']' opinion."

Similar to the research community (e.g. Tobin 2000; Weber, Katz, Waeckerle and Callaham 2002), students recognized the importance of civil discourse in producing the highest-quality peer review. In some cases, students recognized problems associated with an overly critical review process as evidenced by one student who wrote, "I think we should be required to point out the good things rather than bash [reviewed proposals] completely." In contrast, other students were concerned by the overly generous reviews that provided insufficient criticism to authors. For example, one student wrote, "Our group seemed to be too lenient so the proposals reviewed did not get the best feedback possible." In either situation, students expressed concern that some authors might ignore reviews of their work because of the tone of the peer review, resulting in a compromised process.

Broader Implications

Implementation of the funding-panel simulations was intended to introduce another part of the scientific process and

further the development of peer editing. At the time, we, the faculty, did not anticipate the power that this simulation would have for engaging students in discussions about ethics. However, we found that this type of pedagogical innovation had serendipitous impacts. Students discovered ethical implications associated with the peer review process because they participated in a realistic process rather than just reading a case study that exposed them to scientific ethics. We have continued to implement the simulation, partly because of the ethical issues that students engage, but also because this activity illustrates the full scientific process and ties the course together.

There have been logistical challenges to organizing successful funding panels. To align student interests, teaching faculty had to be available to meet and decide which proposals should go to which students. We also had to ensure that each student received his or her two assigned proposals for review. This has been done best electronically through our learning management system. Faculty members also needed to reserve space so that each funding panel had access to a private room. Reviewers' comments and funding panels' decisions then needed to be routed back to authors so that every student could read and reflect on reviews of their work. Again, we found that electronic submissions in which students were asked to type out their comments and submit their reviews online were most effective.

Each panel consisted of at least two reviewers with expertise in the subject area of each proposal. However, faculty members also endeavored to insure that each funding-panel meeting consisted of students who possessed a range of scientific interests. Pulling students together from different backgrounds assured that there was sufficient knowledge to judge each proposal among the group of student reviewers. Requiring students on review panels to communicate and compromise across disciplinary boundaries also allowed them to practice skills that promoted interdisciplinary science (Huutoniemi 2012).

Finally, we had to make arrangements on the few occasions in which a student did not receive a review because a peer failed to complete the assignment and/or attend the simulated funding panel. In these cases we asked suitable student substitutes to complete the additional peer review for extra credit. These events, while disappointing, also allowed for insightful discussions regarding "what happens when someone doesn't do his or her job." Fortunately, this situation occurred rarely. Students appeared to feel an obligation to support peers; students recognized the benefit from the feedback they received from high-quality peer reviews. In addition, the funding-panel simulation created a sense of competition (i.e., "Who's going to get funded?") that invigorated student participation. Finally, the funding panel has worked best when proposals have been exchanged among students in two or more sections of the course, instead of among students in the same section of the class.

The simulation has been sustainable because of the benefits that it has provided to both students and faculty. For example, students have produced higher-quality research proposals as a result of the funding panel, making the final assessment easier and more rewarding for faculty. As importantly, faculty members have expressed appreciation for student interactions, as well as the collaborative teaching environment. For example, the funding panel has made students responsible to each other while giving them appropriate freedom of action to facilitate learning. The activity also initiated the unit on ethics by providing a practical and immediate experience that focused subsequent discussions, which helped students transition into functioning professionals. In addition, the activity has been cost neutral. As a result, it has not required additional financial support from the college.

Similarly structured exercises should be able to engage students with real-life ethical implications in any environment in which students produce a scholarly product. For example, the exercise could be transferred to any STEM (science, technology, engineering, and mathematics) class in which students submit a written scholarly assignment, such as honors theses or the research posters produced in many capstone experiences. With small modifications, the exercise should also fit the needs of any other discipline that engages students in scholarship. For example, students in creative writing could be brought together in a simulated editorial board to evaluate poetry submissions for an undergraduate literary journal. Similar to the funding panel, submissions would need to be reviewed by students in different sections of the same course. Students would then gather to discuss each submission and rank the relative quality of the different submissions. Highly ranked submissions could then be published if the campus had such a journal. Students could still benefit, however, even if the journal were only hypothetical. Similar to our STEM undergraduates, these creative writing students would be expected to produce higher-quality products and learn more about the peer-review process and its associated ethical considerations. To fully engage students in the ethical implications of the discipline-specific peer review process, faculty could lead students in discussions about insights that they realized during the activity. Regardless of the discipline and the particular format of the simulated peer review, the significance of this activity comes from the fact that students make discoveries about ethical behavior and collaboration that develop through their own experience.

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