

AC 2008-1086: JOURNAL CLUBS AS PEDAGOGY FOR INTERDISCIPLINARY GRADUATE EDUCATION

Maura Borrego, Virginia Polytechnic Institute and State University

MAURA BORREGO is an assistant professor of Engineering Education at Virginia Tech. Dr. Borrego holds an M.S. and Ph.D. in Materials Science and Engineering from Stanford University. Her current research interests center around interdisciplinary collaboration in engineering and engineering education, including studies of the collaborative relationships between engineers and education researchers. Investigations of interdisciplinary graduate programs nationwide are funded through her NSF CAREER award.

Lynita Newswander, Virginia Polytechnic Institute and State University

LYNITA K. NEWSWANDER is a Ph.D. student in the School of Public and International Affairs at Virginia Tech. She also holds master's degrees in English and Political Science from Virginia Tech. Her current research interests are interdisciplinary and reside at the intersection of theory and the empirical aesthetic.

Journal Clubs as Pedagogy for Interdisciplinary Graduate Education

Abstract

This paper explores the idea of the journal club as an alternative pedagogy that can help to prepare engineering graduate students for academic and professional life, particularly in interdisciplinary settings. A journal club is a group of graduate students and faculty members which meets regularly to discuss recent journal articles in a specified area of research. Members take turns selecting articles and leading critical discussion of the work. Journal clubs are one method for preparing graduate students for professional life on a number of levels: (1) they familiarize the student to the latest research, methods, and publication trends, (2) they facilitate dialogue and critique among students and professors at all levels of experience, and (3) they allow a space for consideration of interdisciplinary concepts that might not be satisfied by classroom discussions or lab experience alone. We used literature from the Carnegie Initiative on the Doctorate and theory of Communities of Practice to frame our study of an interdisciplinary engineering journal club. Systematic analysis of qualitative field notes and transcripts reveals that these benefits are indeed transferable to engineering and that journal clubs serve purposes which may not be met by other aspects of graduate education.

I. Introduction

Graduate education in engineering aims to prepare the student for professional and/or academic life through experiential research and critical engagement in the classroom. As the demand for engineers trained to work in ill-structured environments increases, traditional pedagogical methods need to be revisited. What worked well for one generation of students may not be adequate for the preparation of today's engineering graduates who must be increasingly innovative and adaptive^{1,2}. Engineering education endeavors to match the best students with the best learning techniques, and must also be creative in adapting and adopting new pedagogical methods.

Other disciplines can be one of the best resources for engineering educators looking for new teaching techniques to fit the unique demands on today's engineers. Because they are also technical fields, the sciences can be a fitting source. Like engineers, scientists are required to know not only their material, but current trends in research, methods, and publication. One way that some of the sciences prepare students for the rigors of real-world research is through journal clubs. These clubs are generally groups of students and professors at varying levels of experience who meet regularly to discuss articles written around a certain topic. Each week, a different member of the group leads the discussion on a different journal article, which has been circulated to and read by the entire group. Journal clubs often include members with different areas of expertise, and perhaps even different disciplinary backgrounds. The result is that the conversation is rich, students learn the skills of critical analysis through participation, and they become comfortable with not only the daunting prospect of publishing and peer-reviews, but also with professional presentation.

Journal clubs are an integral part of graduate education in the sciences, but have enjoyed only limited application in engineering. In this paper we offer an analysis of some of the previously published benefits of journal clubs as graduate pedagogy in the sciences, and argue that the same can be achieved with application to engineering. As a case study, we offer the example of an environmental engineering journal club, which we observed for a full semester. We believe that the successes of this group, including advances in both the scholastic and professional preparation of students, can be adapted more generally to a variety of engineering education settings. Perhaps most importantly, journal clubs can provide engineers with critical thinking skills which are imperative to success, but nearly impossible to impart through traditional methods of teaching, such as lecturing.

II. Literature Review

The existing literature on journal clubs as an alternative pedagogical approach is firmly situated in the biological sciences, particularly the study of medicine³⁻⁶. In fact, medical students have used journal clubs to familiarize themselves with their field for over one hundred years⁷. According to Chris Golde, head of the Carnegie Initiative on the Doctorate, journal clubs are well-suited to the study of the biological sciences because:

1. it is an area of “fast science” where the time to publication is short;
2. there are “clear frontiers of knowledge”;
3. the field is conducted in “communal and relatively democratic ways”;
4. its norms must be “navigated and negotiated”;
5. problem areas evolve and often cross organizational boundaries⁸.

Engineering faculty will recognize that all of these factors also apply to the study of engineering. Thus, the same factors that make journal clubs successful for the preparation of scientists may also work for engineers. Specifically, the literature suggests three key benefits to the journal-club approach to education:

1. They allow users to keep up with the literature.
2. They teach standards for sharing and evaluating research.
3. They cross disciplinary and organizational boundaries⁸.

The unique pedagogical structure of a journal club allows for it to meet the needs of students at a number of levels. In a journal club,

“[a]t its best, the larger scientific community reinforces and extends the development of scientific values that is the most important product of graduate education. Through its various activities and discussions, members of the [journal club] express a set of standards for the quality of scientific inquiry, for what constitutes an interesting problem, for ... rigor, and for ethical ... behavior that becomes the foundation for a future...career.”⁹

We suggest that the same benefits may be found in engineering journal clubs. Although some journal clubs do exist in engineering circles, they are not common, and their relevance to the field has not been studied systematically.

III. Methods

A. Setting and Participants

The setting for this study was a long-standing environmental engineering journal club at a large state university in the eastern U.S. The journal club is headed by a professor who requires participation by all of her research assistants and opens the club to others with similar interests. In the fall of 2007, nine students regularly participated in the weekly meetings. Of the students, five had previous experience with the journal club, ranging from three semesters to three years. The other four student members were new to the club and in the first semester of their programs (M.S. or Ph.D.). Each semester, the club focuses on a different theme. For the fall 2007 semester during which we collected data, the theme was “sustainability.” The group met once a week during lunchtime in a conference room adjacent to the offices of the professor and many of the students.

The journal club functioned as follows: At the start of the semester, each member of the group (the professor included) brought to the organizational meeting two or more articles from scholarly journals that they suggested for inclusion in the semester’s reading list. After hearing a short summary of the works presented by each student, the group chose one article from each member, so that each member had one article for which he or she will lead discussion during the course of the semester. At the end of this organizational meeting, the professor scheduled the calendar for the remainder of the semester, asking each participant (including herself) to lead the discussion for one week. All discussions centered on sustainability. Participants also talked about economic analysis and educating the public as part of sustainability. About half of the time, participants brought in copies of other articles cited in the main article for context. During each discussion, participants went through the paper section by section for the first half of the meeting. It was common for the discussion leader to present supplementary content, usually about chemical processes and reactions studied in the papers. Discussions generally lasted approximately 75 minutes.

B. Data Collection

Permission to observe participants at these meetings was approved through human subjects (IRB) review. Before the first meeting of the semester, we interviewed one long-time participant for background information on the group. At the organizational meeting, we introduced ourselves, briefly explained our purpose for observation, and obtained informed consent from all participants. After the initial meeting and introductions, one observer (LKN) assumed the role of objective observer, sitting away from the group and silently taking notes during the discussion. Discussions were also tape recorded. Our intention was that the observer would not disrupt the pre-existing environment or alter the group dynamic through participation (with the noted exception of the focus group during the final meeting). Each week, the typed notes were reviewed, analyzed, and checked with the recordings, as necessary. Any personally identifying

information in the field notes was removed at this time. The group met a total of 12 times during the semester, including the organizational meeting, which was not recorded. Eleven meetings were recorded, resulting in over 13 hours of tape.

At the end of the semester, the participants encouraged the observer to join the group and present some early findings of this research. The observer obliged, and also used the opportunity to get thoughtful, reflexive answers from the participants regarding their experiences in journal club. Specific questions were: “How is your participation in journal club beneficial?” and “What motivates you to participate in journal club?” This information, coupled with data obtained from the previous eleven weeks of observation, makes a strong case for the benefits unique to the journal club method of pedagogy and the satisfaction of the student participants, described below.

C. Data Analysis

Constant comparative method¹⁰ was employed to thoroughly and systematically analyze our data and arrive at conclusions. Based on information highlighted in the Carnegie Initiative on the Doctorate (CID)⁸, we developed a preliminary coding scheme to test transferability while still allowing additional benefits to emerge from the data. When compared to the benefits stated by the CID, the data suggested an additional benefit to engineering students: because journal clubs allow the opportunity for peer-mentoring, students learn from their active participation as both teachers and learners. This was added as a final code. During the axial coding stage¹⁰, we read through the data, and described the relationships found between the resulting codes. After this final coding scheme was developed and described, the two authors independently applied it to the data. Discrepancies were flagged and discussed until consensus was reached on the proper code for each passage. The coding structure can be found in Table 1.

Table 1. Coding Scheme for Journal Club Data

1. Familiarization to the latest research, methods, and publication trends.
2. Facilitation of dialogue and critique among students and professors.
3. Provision of space for consideration of interdisciplinary concepts.
4. Instances of peer-mentoring and its benefits.

IV. Findings

A. Familiarization to current trends in research, methods, and publication

Perhaps the most obvious benefit of a journal club is that, by requiring them to read the literature, it allows students an opportunity to become familiar with current trends in research, methods, and publication. In the quickly growing field of environmental engineering, this level of awareness is especially important. Students with prior experience in the journal club

demonstrated impressive knowledge of publication standards and venues. When they were uneasy about something they read, they often looked at other articles in the same journal or by the same author, in order to decide for themselves what the norms really are. This resourcefulness was quickly adopted by the new students, as well. For example, one new student had a question about whether cost analysis methods were necessary in a certain paper early in the semester. Looking to justify his own position, he said, “I looked up the first 2 references. Neither of these papers did cost analysis, either.” This is typical of the way that students engaged with the literature—not only with the articles that were assigned and discussed, but with the broader conversation surrounding them, as well.

Students also gained familiarity with the publication standards for particular journals. According to the professor, this awareness translates into high levels of scholarship from her students, enough to earn them recognition at conferences, and, in one instance, even garner a position as a reviewer for a journal while still a graduate student. Journal and conference standards were addressed in every meeting of the journal club, making it an excellent resource for the practical professional development of the students. Some of the more advanced students already had some publishing experience of their own to share. These conversations were always candid, and more often than not, were led by students without interruption from the professor. At a meeting early in the semester, the conversation in Table 2 took place when students were dissatisfied with the amount of research presented in a particular article.

Table 2. Student Journal Club Conversation about Journal Impact Factor.

<p>Student 1: “When they [reviewers] review papers, how much weight do they give to how novel it is, as opposed to how much research is done?”</p> <p>Student 2: “Yeah. Is this a typical paper for this journal?”</p> <p>Student 3: “It’s a low impact journal.”</p> <p><i>(Student 4 makes a face.)</i></p> <p>Student 3: “I’m sorry—did you publish there?”</p> <p>Student 4: “No but I was just about to submit a paper. Not any more.”</p>

In this casual environment, students spoke openly about standards, expectations, and the politics of publication. The professor provided context to these conversations at times, but they were mostly led by the students themselves, as evidenced above.

Other practical considerations include discussions of conference etiquette. For all of these matters, students used each other as resources, relying on the expertise of one another. For example, during a discussion about septic systems, the discussant often referred to two other students in the group who had some research and industry experience. They understood one another well enough to know each person’s expertise. Students were often involved in detailed discussions of methods, as one explained a particular nuance to another.

B. Facilitation of dialogue and critique among students and professors at all levels of experience

New members began the semester admittedly anxious about their level of participation in the group discussions. Three of the four new students were quiet for the first several weeks, only breaking out and joining the discussion after they had done their own discussions. This phenomenon suggests that the individual presentations had positive effects in not only acclimating the students to the group, but in helping them to develop the confidence necessary to contribute to later conversations. In interviews at the end of the semester, these students said that they had been fearful at the beginning, and intimidated by the seniority of the others in the group. However, by the end of the semester, all had gained confidence in their own individual areas of expertise (which they were often called upon to share) and in their capacity for critical thought.

Discussions of the papers grew progressively critical as the semester wore on and students became more aware of the current expectations for publication and the potential biases for funding, research, and publishing. The incidence of critical comments went from 3 in the first week to 20 in the final week. While it may be that the articles themselves became progressively more worthy of criticism, it is more likely that the students themselves became more comfortable with their own ideas and so raised their expectations of other, more established researchers. In one instance of prolonged criticism, the professor implored: “Remember that when you do your own research!” At another time, she said, “Note the statements without any statistical evidence.... You will not get through with that in your thesis, trust me!” These comments are typical of the way that critique and professional development worked together in this group.

Only one of the new members of the group actively participated in the discussions from the beginning. He had a background in the sciences, was not a student of the lead professor, and was eager to learn from the others. In the first meeting, some of his comments were prefaced with self-deprecating statements such as, “this may be shocking to a lot of you, because this is my naïve approach”; “I guess I say that to test the waters, to be sure that I am understanding this correctly”; and “I’m speaking way out of my league here.” Each time he spoke and voiced uncertainty, members of the group quickly responded in ways that justified his position and clarified the content matter. The professor mentioned that others felt the same way, and assured the new student that he was on the right track. Other students chimed in and gave examples to illustrate how the new student’s ideas fit into the discussion. When this new student said, at the end of the first meeting “I can recognize my limitations,” the professor quickly responded “This is your first time through....you’ll pick up stuff. The major things you learn in the process.” Another student offered his own advice, saying, “It took me three months to get up the confidence to speak up in journal club.” This interaction is typical of the ways in which more experienced students encouraged those who were new. By the end of the semester, all were more confident in their own ability to contribute to the discussion.

Even the experienced students were able to learn through careful reading and discussion of the papers. One student, who had been active in journal club for more than three years, began a discussion by saying: “here, I’m gonna go for it, tell you what I think, although I don’t know much about it. I was blissfully ignorant before reading this paper, thinking that resistance was fairly straightforward.” Reading articles from a variety of publication sources and written by

experts with various areas of expertise effectively stretched the boundaries of knowledge for even the most seasoned journal club members. In fact, the professor, who has led the journal club for more than seven years, often reflected on how she was still learning from the experience.

C. Provision of space for consideration of interdisciplinary concepts

The journal club in this study, made up of mostly environmental engineering students and centered on the topic of sustainability, was not incredibly rich in interdisciplinary perspectives. However, due to the nature of the discussion (which was led by the students rather than by a lecturer or expert), the participants were more willing to listen to perspectives different from their own. Only one student member of the group came from a different discipline (in the sciences), and he made an active effort both to learn from and share knowledge with the others. Because the learning environment of the journal club is ill-structured, it lends itself to the inclusion of diverse ways of knowing and understanding a problem. Often during a discussion of a difficult concept, the students would turn to one another for insight. Sometimes this insight came from practical experience, other times from coursework or reading.

During the final meeting of the group, just before conducting closing interviews, the observer was invited to share an article of her own choosing with the group. Seeing this as an opportunity to test the interdisciplinary capacity of the journal club, the observer selected a paper on the topic of sustainability from her own home discipline in the social sciences. The students and instructor were interested in the article, and while the material was unfamiliar to them, they asked appropriate questions and were able to make meaningful connections to their own work. Their behavior during this final meeting demonstrated both ability and willingness to understand interdisciplinary ideas centered on familiar topics.

D. The benefit of peer-mentoring as pedagogical practice

Perhaps one of the most unique characteristics of journal club is that it allows for students to effectively learn from one another. Students clarified technical content for each other by responding to direct questions from other students or a prompt from the faculty mentor. The environment was supportive of newcomers who were often insecure. Importantly, students knew each other well enough to understand that each participant was an expert in some aspect of sustainability with a unique and valuable contribution to make. Students often deferred to one another and actively sought advice or answers from members who they knew to be experts of various topics. In a typical exchange, the conversation in Table 3 took place.

Table 3. Student Journal Club Conversation Revealing Peer-Mentoring.

Student #1: "Student #2, do you want to tell them how it works?" (laughter) Student #2: "Magic!" (laughter, then a pause) "Are you serious?" Student #1: "Yeah, I ask you this all the time. You took the class..." Student #3: "Well, I took the class last semester, and I think it was like this...Anyone feel free to step in on the points I did not do right..."

This conversation is exemplary of the interaction through which students learned from one another. When actively teaching, some students drew diagrams on the whiteboard to explain complex equations as others took notes. Through these interactions, the students demonstrated respect for each other's expertise while at the same time they learned how to explain difficult concepts.

Each participant, no matter how new to the group, acknowledges that the relationship between journal club members is important. The setting is conducive to building relationships, and students often celebrated birthdays—with cake and singing—during meetings. Because students are able to laugh and joke with one another, they are comfortable asking questions of and learning from one another. Similarly, they were not ashamed to admit ignorance. One new student often followed his comments with phrases such as “I’m speaking way out of my league here”—and each time he did, another student immediately dove in to help. It is important to note that students also learn from each other outside of the regularly scheduled meetings. One student pointed out an important nuance, saying that he and another student had been talking about the current topic of discussion in another setting. Also, since most students share the same lab and advisor, it is likely that interactions in the lab and in courses also contribute to camaraderie.

Even though a professor is present in the room, she is on equal footing with the student members. She was careful never to act as a content authority on topics of discussion, and her comments often serve to reassure and encourage students as they think aloud. When specifically asked to reflect on their journal club experience during the final interviews, students invariably said that at the beginning of their involvement, they were afraid to speak up, believing that they would have nothing to contribute. However, because of the friendly atmosphere, where information was shared between peers and no one person's opinion was valued above the others, each of them was able to find the confidence to contribute to the conversation.

In terms of learning theories, journal club can be characterized as a Community of Practice (CoP). In a Community of Practice, members of all levels of experience and with varying backgrounds focus on authentic problems^{11,12}. In educational settings, this lies in sharp contrast to authoritative teachers presenting contrived textbook problems to students. One of the important differences is that learning in a CoP is very much a social process, as students are mentored by several others and model their behavior. Authentic problems motivate students, and the interactions help newcomers learn to make valuable contributions very quickly. While some researchers are working to bring these aspects of CoP into the classroom, it appears that journal clubs have already achieved this as a successful graduate pedagogy.

V. Conclusion

The above mentioned benefits are not exclusive to journal clubs. However, integrating journal club practices into a graduate classroom as a course for credit may dilute its influence. When asked specifically about the effectiveness of journal-club activities in the classroom, the participants of this study noted that the pressure to participate for a grade added stress and that evaluative measures of participation were much too quantitative to allow for the students to develop freely. Furthermore, the relationship between students and the faculty member may be unduly strained by the necessity to assign a grade. Current practice in the graduate engineering

classroom might be improved, however, by the consideration of some of the ideas listed in Table 4. The table suggests strategies for creating a new journal club. These ideas were taken directly from our observations.

Table 4. Strategies for Creating a Journal Club.

<ul style="list-style-type: none"> • Participation should be voluntary and/or culturally enforced, not graded or required as coursework. • Recruit members to a new journal club by describing the career benefits of participation. • Expect to start with a small core group and build up through word of mouth advertising. • Select a topical focus for the semester that is both timely and broad. • Treat students as equals with something to contribute regardless of their experience level. • Enlist the help of senior students or other faculty the first time around so that initial discussions are sustainable, and for recruiting others. • Encourage critical thinking by asking about areas for improvement or extension of the work being discussed. • Tie critique back to students' professional experience with conferences and publishing.

It is possible that a journal club could also be successful on the undergraduate level, although the standards for assessing benefit to students would need to be reconsidered. Still, students at any level of study, especially engineers, would likely benefit from more intimate engagement with both faculty mentors and current literature.

In summary, journal clubs are one method for preparing graduate students for professional life on a number of levels. We used a case study to illustrate how the benefits of journal clubs transfer to engineering to help students learn content of new research developments, norms of peer-reviewing and publishing, and consideration for other (interdisciplinary) perspectives. We used literature from the Carnegie Initiative on the Doctorate and theory of Communities of Practice to frame our study of an interdisciplinary engineering journal club. Systematic analysis of qualitative field notes and transcripts reveals that these benefits are indeed transferable to engineering and that journal clubs serve purposes which may not be met by other aspects of graduate education. While the Carnegie study emphasized professional skills and practical knowledge gained, we argue that process (through which students practice critical thinking and professional skills) is also key to a successful journal club experience.

VI. Acknowledgements

The authors wish to thank the National Science Foundation for supporting this work through grant number EEC-0643107. The views expressed in this paper are those of the authors and do not necessarily represent those of the National Science Foundation. We are also grateful to our participants for welcoming the observer into their group and sharing their reflections at other

times. Finally, we appreciate the assistance of Daniel Boden in discussions of Communities of Practice.

References

- [1] National Academy of Engineering, *The Engineer of 2020*, Washington, D.C.: National Academies Press, 2004.
- [2] Committee on Science Engineering and Public Policy, *Reshaping the Graduate Education of Scientists and Engineers*, Washington, D.C.: National Academies Press, 1995.
- [3] Alguire, P.C., "A review of journal clubs in postgraduate medical education", *Journal of General Internal Medicine* Vol. 13, 1998, pp. 347-353.
- [4] Burstein, J.L., J.E. Hollander, and D. Barlas, "Enhancing the value of journal club: Use of a structured review instrument", *American Journal of Emergency Medicine* Vol. 14, No. 6, 1996, pp. 561-563.
- [5] Kahn, K.S., and H. Gee, "A new approach to teaching and learning in journal club", *Medical Teacher* Vol. 21, 1991, pp. 289-293.
- [6] Kahn, K.S., L.S. Dwarakanath, M. Pakkal, V. Brace, and A. Awonuga, "Postgraduate journal club as a means of promoting evidence-based obstetrics and gynecology", *Journal of Obstetrics and Gynecology* Vol. 19, 1999, pp. 231-234.
- [7] Linzer, M., "The journal club and medical education: Over one hundred years of unrecorded history", *Postgraduate Medical Journal* Vol. 63, 1987, pp. 475-478.
- [8] Golde, C.M., "Signature pedagogies in doctoral education: Are they adaptable for the preparation of education researchers?", *Educational Researcher* Vol. 36, No. 6, 2007, pp. 344-351.
- [9] Hall, Z.W., "Maintaining vitality through change: Graduate education in neuroscience", *Envisioning the Future of Doctoral Education: Preparing Stewards of the Discipline, Carnegie Essays on the Doctorate*, San Francisco: Jossey-Bass, 2006.
- [10] A. Strauss and J. Corbin, *Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theory*, 2nd ed., Thousand Oaks: Sage, 1998.
- [11] Lave, J., and E. Wenger, *Situated Learning: Legitimate Peripheral Participation*, Cambridge, UK: Cambridge University Press, 1991.
- [12] Wenger, E., *Communities of Practice*, New York, NY: Oxford University, 1998.