Research, Teaching, and Service: The Miniconference as a Model for CS Graduate Seminar Courses

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ABSTRACT

Rarely are the three pillars of academia—research, teaching, and service—addressed together, within one intellectually cohesive context in the graduate curriculum. Such a context is important for exposing students to the inter-relationships among these pillars.

This paper presents our experience with structuring graduate research seminar courses around the model of a "miniconference". Throughout the quarter, students pursue original research projects in the discipline of the seminar course. At the end of the quarter, students write their findings as technical conference papers, then act as the miniconference program committee in reviewing each other's submissions. Finally, the selected papers are presented at the miniconference. In addition to the model itself, the paper describes some variations in instantiation and an assessment of the benefits of this general approach.

Categories and Subject Descriptors

K.3.2 [**Computers and Education**]: Computer and Information Science Education—*curriculum*

General Terms

Design

Keywords

Pedagogy, graduate seminar courses, oral and written communication, technical reviewing, professional service

1. INTRODUCTION

For the last two years, we have experimented with designing graduate research seminars to culminate in a "miniconference". This model blends the three pillars of academia—research, teaching, and service—within the context of a single course. The goal is to create a microcosm of the academic experience, where students can see the interplay among these diverse responsibilities. Students carry out original research projects, write up their results in technical papers, and present their work at the miniconference during the last class. During the term, each student is responsible for giving a lecture, typically on background material related to their research project. Finally, students gain an appreciation for professional service by acting as the miniconference program committee, reviewing their peers' submissions, and making acceptance decisions.

Although there are some significant challenges in implementing this model for graduate seminar classes, we have found the framework to be remarkably effective. The success of this framework is robust to many permutations and variations in organizational structure.

The remainder of the paper is organized as follows. Section 2 presents our motivation in developing the miniconference model. Section 3 compares this model to similar curricular frameworks that have been presented in the literature. Section 4 outlines the skeleton course structure, grading scheme, and some variations on the basic model that we have explored. Finally, Sections 5 and 6 review the outcomes and summarize our findings.

2. MOTIVATION

One of the many roles of a Ph.D. graduate program is to prepare the future faculty of the discipline. In this sense, the graduate student is an apprentice, learning by example while working closely with a faculty advisor. Students see first-hand the principal aspects of faculty responsibility: research, teaching, and service [8].

Students see these responsibilities reflected, to various degrees, in their curricula. The curriculum of a doctorate program can typically be divided into two broad categories: core courses that emphasize the foundational elements of the discipline, and advanced courses that emphasize current research developments in a particular sub-discipline. The former are often traditional-format classes and provide the broad intellectual foundation deemed essential for anyone holding a doctorate in the discipline. The latter are often seminar-based and expose students to the knowledge frontier and current research questions of a specific area.

Both categories of courses support the primary focus of doctorate studies: research. While the course work lays the technical foundation, the research focus of a Ph.D. program is most directly reflected in the dissertation. Through the pursuit of original dissertation research, students develop and refine their research skills as they undertake significant projects that advance the state-of-the-art in their chosen subdiscipline. Students participate in the writing of technical papers to disseminate their results and also present their work at professional conferences. Senior students are occasionally involved in grant-writing to expose them to this aspect of the academic research culture as well.

Although it is not the primary focus of most doctorate programs, students do acquire some basic teaching skills as well. As teaching assistants, students experience first-hand the challenges and rewards of pedagogy. Whether grading, leading a recitation section, or acting as primary instructor for a lower-level undergraduate course, graduate TAs gain practical experience in evaluating student performance, answering student questions, and engaging students in the presentation of course material. Students also develop teaching skills in the classes and seminars that involve oral presentations. This environment provides direct feedback both from peers and from the instructor. Finally, students may also learn about teaching by simply observing their most effective professors while they lecture. Thus, opportunities for graduate students to hone their their teaching skills are primarily serendipitous. Academia has been criticized for inadequately preparing future faculty for their teaching responsibilities [17], and we do not dispute this general claim.

The service component of academic responsibility does not generally appear, directly or indirectly, in the typical graduate program. Opportunities for professional service do exist, of course, for graduate students. Many large CS conferences, such as SIGCSE and ICSE, rely on student volunteers in order to run smoothly. Most departments and universities have some form of student governance. Students can also become involved in local chapters of professional organizations or honor societies. It is up to the individual students, however, to avail themselves of these opportunities.

The contribution of this paper is a model for combining research, teaching, and service within the intellectually cohesive context of a single seminar course.

3. RELATED CURRICULAR DESIGNS

The importance of written and oral communication has been widely recognized. The IEEE-CS/ACM Computing Curricula 2001 recommendations identify communication as one of the principal "transferable skills" vital to all CS graduates [18]. These skills are relevant to the research, teaching, *and* service aspects of academic responsibility.

3.1 Developing Writing Skills

Many approaches exist for integrating technical writing with computer curricula. Opportunities for developing students' writing skills have been observed at all course levels, from introductory to advanced [4]. Inter-disciplinary collaboration (*e.g.*, between the CS and English departments) has proven to be effective [16, 11], but is not strictly necessary and many effective techniques exist for developing writing skills within CS courses [12, 5, 7, 19]. Assessment of such efforts has included statistical studies to quantify their effect on student perceptions of their learning experience [6].

Many of these approaches do not explicitly address the process of writing a technical research paper. With a course-ending miniconference, students know they are writing for a program committee, and can target their papers accordingly.

3.2 Developing Reading and Critiquing Skills

A natural complement to the ability to write effectively is the ability to read critically. Having students review published papers is one way to promote critiquing skills. This approach appears to be effective regardless of whether papers are taken from the current literature [11] or taken from a list of classic research papers [2]. Peer-review, where students review each other's work, is another mechanism for teaching this skill [14]. Peer-review of writing has been used in a variety of ways within CS courses [5, 1, 7, 10].

As with these other approaches, our miniconference program committee was charged with providing feedback that could help the authors improve their papers. In addition, the program committee was also required to evaluate the submissions against each other and make an assessment about which to accept for the miniconference.

3.3 Developing Oral Skills

Seminar courses often involve student presentations. Given the importance of this professional skill, educators have looked for deliberate ways to encourage its development through curricular design [9]. Graduate students also give technical research presentations to a variety of audiences, ranging from peers within their own research group, other students and faculty within their own department or university, and other researchers in their field at professional meetings. Candidacy exams and final defenses further reinforce the importance of clear articulation of technical concepts.

Learning to give an effective technical presentation, however, is not the same as learning how to teach. The miniconference model allows students the opportunity to do both, and thus observe both the similarities and differences.

3.4 Developing Citizenship Skills

Many instructors reserve a small amount of the total grade for "class participation". This component of the grade is actually an evaluation of the student's citizenship within the class, although it is rarely phrased in this way. Another form of professional service is the refereeing of technical papers. Students gain an appreciation for this process as they submit their own papers and receive feedback from reviewers. Senior students may also participate as reviewers themselves.

Our miniconference approach gives more direct insight into the nature of professional service: the care and diligence with which technical reviews must be undertaken and the complexity of conflict of interest issues in making accept/reject decisions.

3.5 Preparing Future Faculty

The monumental nature of the task of preparing future faculty has led to some significant efforts. Many universities have created interdepartmental seminar courses for senior graduate students to discuss issues related to academic careers. Authors have written books [13, 3] with advice for prospective faculty. The NSF and CRA have each sponsored national summer workshops for junior faculty.

It is far too ambitious to hope to solve this problem with a few individual seminar courses. However, the modest effort of our graduate seminar miniconference provides another element of a solution for this complex challenge.

3.6 Undergraduate Conference Model

The conference model within CS courses has been explored in a variety of settings and with a variety of goals. In [1], the authors report on a conference model in which undergraduate students engage in independent research, technical writing, and oral presentations. Students do not, however, participate in the reviewing and refereeing process. In [10], the authors describe a conference model to promote deeper understanding of core undergraduate material and to hone communication skills. While students do participate in peer review, the projects are designed to reinforce principles from the course, rather than to develop original results. In [15], the authors present a general conference model and apply it to undergraduate courses of various sizes.

All of these projects describe an *undergraduate* conference model whose primary goal is to improve the students' communication skills. Our miniconference model, in addition, aims to expose *graduate* students to the interplay among research, teaching, and service.

4. THE MINICONFERENCE MODEL

4.1 Course Structure

The course is divided into three phases. In the first part, students attend traditional lectures and begin their research projects. In the second part, students present minilectures to the rest of the class. Finally, in the third part, students participate in a miniconference: they submit research papers, review each other's submissions, make acceptance decisions, revise their papers, and present their results.

The course begins with the distribution of a fictitious call for papers. Potential projects and research questions are described at the first class meeting, and students choose topics to pursue for their original research project. Although students do not have the technical background, at this point, to *complete* their projects, they can still identify which projects will likely be of most interest. Based on these interests, teams are formed.

The first part of the course is devoted to covering the core technical content. This is done using the traditional delivery mechanism of that seminar (*e.g.*, through a series of formal lectures by the instructor, or by directed readings and round-table discussions). Concurrently, students begin their projects. Weekly meetings with the instructor can be used to track and promote progress.

The second part of the course is an opportunity for students to teach. Students prepare minilectures on course topics most directly related to their research projects. These minilectures typically draw from both textbook material and a synthesis of published related work. The intent is that students observe some degree of synergy between their teaching activity and their research project. On one hand, their research benefits from their teaching activity since the background work necessary for preparing the minilecture is relevant to their project. On the other hand, their teaching benefits from their research activity since their investigations can provide context and direction to their minilecture.

The course culminates with a miniconference during the last class meeting. Each group submits a technical paper according to the page, format, and content requirements stipulated in the call for papers. They are told that accept/reject decisions will be made based on these submissions.

The class as a whole then acts as the program committee for the miniconference. Each submission is reviewed by three or four students. Although the submissions are done by student groups, the reviewing is assigned on an individual basis. Reviewers are asked to provide a description of the paper's strengths and weaknesses, recommendations for its improvement, and an assessment of its quality. Reviews are given to the instructor (for grading) then distributed anonymously to the entire program committee. The entire class then meets to decide which papers to accept for the miniconference. Authors are excused during the discussion of their papers to ensure a frank assessment.

At the miniconference, the selected papers are presented. Talks are given under time constraints that are similar to those of a typical conference. The format is also more structured than the minilectures given earlier. For example, questions are generally held until the end of each talk.

A debriefing session is held after the miniconference to reflect on the experiences of the class. The qualities of effective minilectures can be contrasted with those of effective technical presentations. Another useful discussion is an analysis of qualities that make papers more likely to be accepted. It is also important for students to reflect on the reviewing and assessment process encountered during the program committee meeting. Finally, students are given an opportunity to incorporate reviewer feedback in "camera-ready" versions of their papers (whether originally accepted or not).

4.2 Grading Scheme

We have found it helpful to explicitly pattern the grading scheme after the three aspects of the course: research, teaching, and service. We have used a weighting of: 55% research, 25% teaching, 10% service, and 10% class participation.

The grade for the research component can be further subdivided. For example, we have used the following parts: (i) completed project (as evaluated by instructor through weekly meetings), (ii) submitted paper (as evaluated by the program committee), (iii) camera-ready paper (as evaluated by the instructor), and (iv) contribution evaluated by project teammate. For the second part listed above, we have used a strict translation of the PC outcome: rejected papers get 0 to 4 depending on the strength of rejection, while accepted papers get 5 to 10 depending on the quality of the presentation.

For the teaching component of the evaluation, we use a combination of student feedback from the minilectures and instructor evaluation. Students are given a list of criteria on which they will be judged. This list is divided into two categories: content and style. An emphasis is placed on communicating the key aspects of the topic in a clear and organized manner.

The grade for the service component is based on the quality of the submitted reviews and the contribution during the program committee meeting. Direct feedback on reviews is given, but students also receive indirect feedback during the PC meeting by observing the other reviews that were written for the same paper.

4.3 Variations

We have found this model to be flexible enough to accommodate a number of variations on the skeleton structure described above. We hope that this robustness encourages other educators to apply this model to their own advanced seminar courses at their own institutions.

Different organizational structures can be used for forming and managing student groups. In small enough seminars, weekly meetings with the instructor can be used to guide projects. We have also experimented with self-managed groups, where each group includes a senior graduate student who acts as "project advisor". Finally, we have also had some students work individually (by their choice). All of these team structures have supported a successful instantiation of the miniconference model.

The selectivity of the miniconference is another adjustable parameter. We have used acceptance rates ranging from 30% to 100%, according to instructor preference. The results have been uniformly well-received. The more competitive acceptance rates do create a different dynamic in the PC meeting. We encourage adopters of this model to have some selectivity to their miniconference, and thus expose students to the assessment aspect of professional service.

A third variation on the miniconference theme involves the amount of time allotted for revising the paper in response to reviewers' comments. Rewriting and revising are important elements of effective writing, so, ideally, students would be given several weeks to address these comments. On the other hand, there must be enough time *before* the miniconference paper submission deadline to allow research projects to complete. Thus, one must balance these two conflicting priorities. Again, we have experimented with revision windows ranging from 0 to 2 weeks and the success of this model does not appear to hinge on this choice. Nevertheless, we encourage adopters of this model to allow at least one week for revisions.

5. ASSESSMENT

Because our experiences are based on different variations mentioned above, we attempted no systematic assessment of outcomes. There were so many confounding factors (including many set up by us precisely so we could simply observe what would happen) that any sort of experimental evaluation seemed premature. Our assessment is therefore based on personal observations and anecdotes. At this point, however, it should be possible for someone interested in carefully assessing the model to select a particular instantiation of it, and to design a rigorous study.

5.1 Student Feedback

We noted at the end of one version of the course that some students seemed genuinely surprised by the novel course structure, in both positive and negative ways. For example, one international student remarked that he "had not done presentations" in his undergraduate classes but appreciated the opportunity. Most U.S. students countered that they had done presentations before, although not in the research conference style. Another student was "uncomfortable with the lack of structure" of the class meetings during that term, many of which consisted of design-by-committee sessions in which the entire class collaborated on the design of some software component interface. His conclusion was that the professor was "not prepared for lecture" and had to fall back on group discussion! Generally the same kinds of concerns could be voiced in many standard graduate seminar formats when students are used to standard lectures. But these comments suggest that it is important to tell the students that they will be in an unusual classroom situation in which the objectives go beyond their learning the nominal course content.

5.2 Student Learning

We were pleased to see that, as far as we could tell, embedding the usual course material into the miniconference format did not significantly affect what students learned about the nominal technical content. Little course time was "wasted" on overhead. The abbreviated but still effective PC meeting required one class period, and the presentations were held in lieu of a final exam (which is often the case in a graduate seminar in any event). So educators wishing to wrap this model around an existing graduate seminar should find that it does not significantly interfere with the existing schedule. Hence, students have about as much exposure to the underlying course material as they would have without the miniconference.

On the other hand, most students did learn things about the nature of an academic job that they otherwise would not be exposed to in a typical seminar course. For most students, this was their first experience reviewing someone else's paper and having to write a true critique as opposed to merely a summary. Most students struggled with having to reject papers written by their peers and in doing so, we believe, learned something about the processes of academic peer review and also about the possibility for subtle conflicts of interest and how they might be handled. Moreover, not everyone reviewed every paper, so students learned that decisions often are made based on championing. These lessons should be valuable to them in all professional endeavors.

As part of course evaluation and debriefing, we asked the students specifically what they had learned about writing a research paper. Their responses came both from seeing reviews that others had written about their papers, and from writing reviews of papers submitted by other groups. None of these lessons is surprising in the sense that it has not been noticed before. But it was clear that many students had not previously thought about most of these issues.

1. Package one "big idea" per paper—not zero, not two, certainly not more than two.
2. Find a short but informative title.
3. Write a concise informative abstract (*e.g.*, do not use phrases such as "in this paper..." or "we show that..."; do not focus on the motivation but on the results).
4. In Section 1, explicitly identify your audience, tie the paper to the conference theme, and state the contribution of the paper.
5. Be consistent in all matters throughout the paper: formatting, language, level of detail, experimental designs, *etc.*
6. Use examples, and start them as early as possible.
7. Spell out acronyms on first use.
8. If you intend to report experiment results, use careful experimental design and draw only statistically valid and supportable conclusions. Use error bars in graphs, not just averages.
9. If you put code in a figure, explain it in the text.
10. Don't exaggerate or embellish conclusions. Acknowledge when you know something and when you don't.

11. Use a spell-checker and grammar checker just before submitting the paper.

5.3 Other Outcomes

None of the completed papers was immediately ready for publication. However, about a third of the miniconference papers have gone on to mature into real conference submissions, and at least one other is in progress.

6. CONCLUSIONS

The miniconference model is an effective framework for structuring graduate seminar courses. It is important to note that the primary focus of the seminar remains on delivering the technical content of the course. The miniconference structure for this content, however, has several significant benefits. Students improve their written and oral communication, and appreciate the importance of appropriately targetting their papers or presentations for their intended audience. Students also gain experience in critiquing and assessing technical papers and, conversely, incorporating such critiques into their own work. Finally, students are exposed to the interplay among research, teaching, and service in the academic environment.

At the core of the miniconference model is the creation of a microcosm of academia. As there are many models of the academic environment, however, there are also many valid distillations of this environment. The balance between research and teaching, for example, is clearly an issue of design in applying the miniconference model.

The miniconference approach to seminar courses has a role to play in preparing future faculty. Experiencing a microcosm of research, teaching, and service has clear benefits for students who will go on to academic appointments. Of course, the majority of students will not continue on to faculty positions, but for these students too the model has the professional skills benefits outlined above. Finally, for students who are undecided about career path, the model can help illuminate and inform their choice.

We have applied this model to seminars in software engineering and distributed systems. Its generality, however, makes it suitable for instantiation in any subdiscipline.

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