

286b The Research Proposal in Biochemical and Biological Engineering Courses

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The advancement of the economy in the United States is critically dependent on continuing new developments in science and engineering technology. Undergraduate students in engineering typically receive good training in how to solve well defined problems. However, they usually receive very little training in the creative activity that is involved in the development of new technology; often, students read only their textbooks in engineering courses. One way to get students to think creatively about developing new technology is to incorporate a requirement for a research proposal into the course. Although numerous efforts have been made to incorporate more writing into engineering and science courses, relatively little has been reported about using research proposals in courses taken by undergraduates. In this paper, our experiences in incorporating a research proposal in four courses in biochemical or biological engineering for upper-level undergraduates and graduate students are presented. Biochemical and biological engineering are broad fields undergoing rapid development and have many opportunities for students to write research proposals on the advancement of science and engineering.

A research proposal was required in each of the following courses: Biochemical Engineering, Biosensors, Cellular Aspects in Tissue Regeneration, and Tissue Engineering. Each of these courses is an upper-level engineering course for juniors, seniors, and graduate students. The selection of the research topic and the development of the objectives and significance by each student were very important to successful proposals. Students were allowed to choose a proposal topic they had an interest in, based on their own research and/or prior courses in the biological sciences or bioengineering. Each student met with the instructor to discuss the appropriateness of the topic.

Our main observations are the following: (1) Writing a research proposal was a challenge for the students in these four courses. It was the first time that any of them had been required to write a proposal, with the exception of a few students who had written a proposal in one of the four courses in a prior semester. For many of them, it was the first time that they had been required to do reading outside of the assigned textbooks in a course. In addition, we observed that students tended to underestimate the difficulty of writing a proposal, especially in coming up with new ideas to research. (2) Breaking the requirements down into segments (such as a summary with specific aims, rough draft, and final draft) due on different dates helped make the assignment more manageable for the students. Giving the students written or oral feedback about each of the segments helped the students do a better job on the next segment that was due.

By the final draft, a great majority of the students was able to produce a proposal without major problems. We found that roughly one-fifth of the students wrote proposals that presented new and unusual ideas that were well explained and which could serve as the basis of a proposal to a federal granting agency. Undergraduate students performed about the same as graduate students on the proposal.

Our observations, based on talking to students about their proposals and reading the students' proposals, were confirmed by an anonymous survey taken of the students in these courses. By a large margin, students thought that the research proposal was a good way to learn about a topic in bioengineering in depth. A majority of the students either agreed or strongly agreed that the research proposal involved more creativity than any other assignment they had completed at OU, gave them a better appreciation of how new technology is created, and was one of the most challenging assignments they had at OU. All of the students either agreed or strongly agreed that writing a research proposal in the course helped with another courses or courses taken afterwards and/or helped with a research project.

We conclude that requiring a research proposal is an excellent learning experience for upper-level undergraduates, as well as graduate students, in biochemical and biological engineering courses. Writing a research proposal requires a higher level of thinking than for a normal term paper, where the student is typically required to review the technical literature on a given topic. By proposing new research, the student is required to think more even critically about the previous research and to consider how to advance science and technology in the field. Besides being used as part of a biochemical or biological engineering course, a research proposal could be used as the requirement to fulfill an undergraduate research course (for example at the University of Oklahoma, the courses Honors Research, Undergraduate Research Experience, or Senior Research). The requirement of a research proposal could also be able to be applied in other upper-level engineering courses on topics where technology is advancing rapidly.