



Improving an Upper Level Biology Course

Hasan Deniz*, William S. Harwood**

* Doctoral Student, Curriculum & Instruction, Indiana University School of Education, Bloomington

** Associate Professor, Curriculum & Instruction, Indiana University School of Education, Bloomington

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ABSTRACT

This paper critically examines the place of traditional lectures within the context of an upper level biology course in an increasingly technological large American university. We examined a professor's effort to improve his course by incorporating weekly student presentations. This organizational change in the course resulted in the removal of about one-third of the content previously covered. The presentations were successful at engaging students, but additional pedagogical changes were identified that may improve student engagement. Our results suggested that knowing content is necessary but not sufficient to keep students engaged and explain complex biology content in an understandable fashion.

Keywords: *Lecture, Virology, Student-Engagement*

INTRODUCTION

Science faculty have become increasingly interested in reforming courses and curricula. One point of attack in reforming college science courses is the lecture presentation (Lord, 1994; Weld, 2002). There is now general agreement among science educators that traditional lecture, with its structure of a teacher talking and students writing, is not the most effective means of helping undergraduates learn science. Rather, we are encouraged to move from this passive mode to more active modes of learning during our "lecture" time (Siebert and McIntosh, 2001; Zoller, 2000). How much of a change in the traditional lecture format should be made is a question each reform-minded professor must wrestle with.

Some education researchers advocate eliminating the traditional "sage on stage" and taking a completely new approach (Ebert-May, 2001). Others suggest a more gradual approach (Gess-Newsome, Southerland, Johnston & Woodbury, 2003; Taylor, Gilmer & Tobin, 2002). One of the most popular replacements for lecture is some form of student group work (Leonard, 2000; Wyckoff, 2001).

This paper explores the effort by a senior faculty member in a Biology department at a large midwestern university in United States to improve his upper-level course in Virology. He has taught this course for more than 30 years in a traditional lecture format. After discussion with us, the professor chose to take one class period per week as a day for student groups to make presentations on a current issue in virology. The remaining two class periods would remain as a traditional lecture.

Setting and Intervention

The study was conducted on a three-credit, 400-level course in virology that is a requirement for the microbiology major. The course met three times per week (MWF) for 50 minutes. Most of the fifty students were seniors or juniors that had completed the necessary pre-requisite courses. Prior offerings of the course used a traditional lecture format with the visual information presented on an overhead, slides or drawn on the blackboard. For the semester we studied the course met in a technology rich environment equipped with an Apple and a PC computer, an extra-large screen, a projector, Internet access, a VCR, an overhead project, and a document reader. The professor put his notes on a class website and projected them during lecture. He also used a mixture of overhead transparencies from previous years' lectures, wrote on the blackboard, and occasionally projected pages from books using the document reader.

The course continued to have traditional lecture on Monday and Wednesday of each week. Friday was reserved for student group presentations exploring topical issues in virology such as smallpox, yellow fever, bio-terrorism, measles, and HIV. Students were alphabetically assigned by the professor to one of 10 groups of 5 students each. The professor assigned a different topic to each group, met with each group once, and provided each group with guidance regarding where to find relevant materials and information regarding the presentation topic.

The driving questions for our study were:

- What is the perception of professor and students regarding the course as a whole?
- Is there any evidence of crossover between "lecture days" and "presentation days" regarding student engagement and/or instructor interaction with the class?

METHODOLOGY

We used a naturalistic approach to this study. Our data consisted of instructor interviews, student interviews, classroom observations, and student evaluations. Interview protocols for students and the instructor are in Appendix. We observed the class two times a week for 15 weeks—the presentation day and one lecture day. Observations focused on the instructor's manner of presenting the subject matter, amount of time that the instructor talked and the students talked during class, student-instructor interactions, and number of questions asked by students.

We interviewed the professor in the middle of the semester and again at the end of the semester. Questions focused on the factors that motivated him to make a break from the lecture format, strategies that he followed to increase student engagement during the class, his past experiences that prepared him to incorporate student presentations to the course, and the satisfaction that he received from incorporating presentations. We interviewed five students in the middle of the semester and a different group of five students at the end of the semester. Questions focused on students' expectations from the course, how they evaluated the course in terms of student-centeredness and teacher-centeredness, what they thought about the content of the course, how much communication and interaction were going on among the members of the class, whether they asked any questions both inside and outside of the class to the professor, whether they

felt comfortable while they were asking questions, what kind of questions the professor was asking and what they thought about presentations that were incorporated to the course. We also collected student assignments and exams, and made copies for later analysis.

Qualitative data analysis followed a protocol similar to that described by Tobin (2000) for interpretive research. The authors coded the qualitative information independently and emerging patterns were discussed. Disagreements were handled by referring back to the data and examining results more closely until resolution could be achieved. Validation of developing trends and patterns was obtained by discussion with the instructor. This step is also important in improving the course by providing the instructor with insights from the research.

FINDINGS AND CONCLUSIONS

The instructor of the course had taught in a traditional manner for more than 30 years. However he has come to feel that there needs to be a change in the course structure in order to engage students more effectively in his subject of virology. His experience from a small seminar class where students brought in materials from the popular press led him to consider presentations as a means to engage his students. He initially had some reservations whether the presentations could work in a class of fifty students

In spite of initial concerns regarding using presentation in a large class, the professor decided to implement this change in course structure. His goal was to see evidence of active and engaged students discussing key ideas in virology. At the same time, the professor was not prepared to relinquish a sense of control. He made the assignments of students to one of 10 groups and chose the topic for each group. He met with the groups and provided some materials on that topic and guidance toward additional material. Only then was each group left to digest the information on their topic and develop their presentation to the class.

Setting aside one day per week for presentations, however, necessitated a reduction in course content by about one-third. This can be a stressful challenge for faculty because they see the relevance of all the content or they feel compelled to present a certain "cannon" of content. The literature strongly encourages content reduction as one step toward increasing student understanding of the remaining material (see, for example, Allison, 2001; Nelson, 1989; Nelson, 2001). In this case, however, the professor reported that he was comfortable with the reduced amount of content covered. Moreover, we found no evidence that content in the two lecture days was increased (first author, HD, took this course in the previous offering) indicating that the professor did not try to compensate for the lost lectures and genuinely reduced the content. The professor was pleased by the new format and reported that he enjoyed the presentations provided by the students.

I thought that the presentations made a difference. I thought it was good. I thought that the students got quite a bit out of it. I enjoyed doing it this way. I think I will continue doing it this way.

Students felt that the course material presented during lecture days was overwhelming. In spite of their feelings of content overload from the lecture portion of the course, students felt a good rapport with the professor and reported that they liked the course and learned a lot of valuable information. The main frustrations reported by the students involve the lack of an explicit structure for understanding the material. Students believed that a clearer structure would not only help them in understanding what/how to study for exams, but generally would improve their learning.

The lectures presented by the professor were detailed descriptions of complex ideas in virology. Most of the students were motivated to learn this material and came to class regularly and prepared. Observations of the lecture, however, suggest that the instructor could increase the clarity of the lectures by any number of straightforward techniques. For example, the professor could provide a number of questions that could be addressed by the lecture for each day. This technique addresses the issue of guiding students regarding pertinent exam item study, but also serves to frame the lecture. Alternatively, the professor could provide a brief outline of the key points of each lecture.

Generally, students came to class prepared by having read the professor's notes posted on the course website. Students found it difficult to process the information presented during lectures. That is, they found the pace of lectures too fast. According to the cognitive information processing view, the human learner is considered to be a processor of information in much the same way a computer is. When learning occurs, information is input from the environment, processed and stored in memory, and output in the form of some learned capability (Driscoll, 2000). This computer analogy can be helpful for instructors who lecture. After taking in some information, students need an opportunity to make the information meaningful in their mind. This suggests that lecture should stop from time to time and an activity or discussion take place that will identify and clarify any points of confusion (Harwood, 2004). One of the students commented on this issue,

I found myself just trying to intake what he is saying. He was very quick. By the time he starts on one topic he is already to another one before I am able to write it down.

Although students felt a good rapport with the professor and reported that they were comfortable with asking questions of the professor, we observed that there were not many questions asked during the lecture. Our observations suggest that the atmosphere in the lecture was not conducive to students asking questions. Comments from two different students below show that students are not comfortable asking questions during the lecture.

I think you need to think about whether your question is valid or not to the rest of the students because I am not as concerned sometimes with figuring out the answer to my own question as making sure that rest of the class is not bored by the answer to my question.

I do not think I have ever asked a question in class. I have asked some questions outside of class during the lab period.... Just because people are doing their own things, you can actually approach one-on-one. That is the way, I like to ask questions better.

These comments indicate that lecture settings are impersonal and these impersonal settings discourage students from asking questions. The only exception to the pattern that we described above occurred on rare occasions when the professor mentioned his lab experience, referred to real-world issues in virology, or issues from virology conferences. During these occasional interludes, students' level of engagement went up and more in-class questions were asked.

The group presentations, however, were viewed positively. Students enjoyed the presentations of others and also the process of doing a presentation. They valued the opportunity to learn the details about a topic in virology through the process of research and creation of a presentation. When other groups made their presentations, students in the

class appreciated the clarity of the day—typically one virus was discussed—and the focus on a real-world topic that interested them. Students also found the process of literature-based research and creating the presentations to be valuable for their understanding of virology and their development as future professionals.

The classroom became dynamic on presentation days. Our observations suggest that the presentations achieved the desired goal of increasing student engagement in the course, but this engagement is restricted to the presentation day itself. Students asked questions of the presenters that were often pertinent and open-ended. Discussions were typically focused and well handled. Our observations also suggest that a rubric would help ensure that students understand what was expected of a high quality presentation. Students wanted an explicit reward for their presentations. Interestingly, students did not express this as a motivational need or necessarily connected points for presentations to their grade for the course. The public nature of the presentation seemed to be enough, in the minds of students interviewed, to provide motivation to produce a quality presentation. Rather, the students had a high opinion of the quality of their presentation and wanted that quality to be acknowledged through a grade or score.

DISCUSSION AND SUGGESTIONS

Although there is a lot of support for inquiry oriented instruction in science classes by major science education policy documents (AAAS, 1993; NRC, 1996), lecture format is not likely to disappear in near future because of the large class sizes. It is also not likely to disappear because it is one of the major sources of income for universities. Considering these realities, lectures should be seen as a teaching tool that needs to be made effective and supported by student-oriented activities. Lectures should be arranged in a way that they should engage students. Instructors who lecture should see lecture as a two-way communication channel instead of one way communication channel. Students should come to class by being aware of what is going to be covered, they should be provided with a clear organizational guideline which summarizes the major points in the lecture. Instructor should stop from time to time; give students an opportunity to make sense of the information presented and to ask questions. Students should be allowed to discuss lecture material in small groups and ask any point of confusion or misunderstanding to the instructor individually or as a group.

Lectures should not be simply seen as a way of transferring information from instructor to students. Instructors should focus on conceptual connections between different aspects of the content during the lecture. Conceptual connections should be made clear to the students, which is difficult to obtain by simply reading the textbook and lecture notes. If the lectures are mere regurgitations of lecture notes and the textbook, student engagement would be low and higher level conceptual understanding of the content would not be achieved by most of the students. Our findings suggest that students found the process of literature-based research and creating the presentations to be valuable for their understanding of virology. Therefore, students should be encouraged to take responsibility for their own learning thorough literature review and student presentations.

Science faculty who have teaching responsibilities should try to take their teaching responsibility as serious as their research responsibilities. Teaching should not be seen as a burden. Collaboration between science faculty and science education faculty seems promising to better the learning atmosphere in science classes. Science faculty should realize that there is more to teaching than simply knowing the content. Instructors' understanding of a subject matter is necessary but not sufficient for student learning to occur. Shulman (1987) phrased the term "pedagogical content knowledge." He defined pedagogical content knowledge as "a special amalgam of content and pedagogy that is

uniquely the province of teachers.” Pedagogical content knowledge requires willingness on the part of the teachers to make the content readily understandable to students.

In this study, both the professor and students felt that student presentations were successful, but changing this one aspect of the course was not sufficient to create the desired student engagement during the regular lectures. At the same time, however, observations and the results of analysis of student derived data (interviews and evaluations) suggest that additional modifications of the course, such as by providing clearer organizational cues, could result in a positive impact on student sense of engagement. Further changes in the pacing of lecture may also result in a positive effect on students’ engagement in the course. We believe that lecture format can be used effectively in large classes, but the success or failure of these lectures will be dependent upon how these lectures are organized and the instructors’ level of pedagogical content knowledge.

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APPENDIX

Interview Protocols for Students and the Instructor

Interview Questions (for the instructor)

- 1- What motivates you to increase the engagement of your students after 30 years of teaching?
[How did your previous teaching experiences affect your decision about increasing student engagement?]
- 2- Do you encourage your students to work collaboratively? [In what ways?]
- 3- How long do you think that you talk during a one-hour class?
- 4- How long do you think that your students talk during a one-hour class?
- 5- Do you encourage your students to ask questions during the course? [In what ways? During class? Why/why not?]
- 6- What do you believe are some of the incentives that make students more engaged in the class? (extra credit, self satisfaction) [What are other mechanisms that might encourage students to become engaged?]

Interview Questions (for the students)

- 1- Why are you taking this course?
- 2- What are your expectations from this course?
- 3- What do you think is the instructor's responsibility in teaching this subject?
- 4- What do you think is your responsibility in learning this subject?
- 5- Do you think that this is a learner-centered or teacher-centered class? Why?
- 6- How often do you come to class?
- 7- Do you think that attending the class increases student success?
- 8- Do you think this course covers the right amount and right mix of material? Explain.
- 9- How much communication and interaction do you think is going on among the members of this class?
- 10- Do you feel any responsibility for the success of others in this class?
- 11- What could the instructor do to increase your motivation during the class?
- 12- Do you think that there is a correlation between your engagement with the course and your success?
- 13- Do you feel comfortable asking questions both inside and outside of the class?
- 14- Do you ask questions outside of the class to the instructor of the course?
- 15- Are you working harder than you thought you would for this class? [In what ways?]
- 16- Do you think that you made a good decision by taking this course?
- 17- Do you think that your instructor is asking higher-level questions? [Rather than memorization questions.]
- 18- How long do you think that students talk during a one-hour class?
- 19- How long do you think that your instructor talk during a one-hour class?