Student-Centered Learning for the Confirmed Lecturer

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Abstract

Research shows that the traditional classroom teaching method known as lecturing, in which the instructor (lecturer) primarily speaks and the students primarily listen and take notes, is very ineffective [1,2]. Many alternative methods of teaching and learning, that are basically student-centered rather than teacher-centered, and which require the students to be active rather than passive in the learning process, have been developed. In spite of these facts, many engineering professors continue to teach using the traditional method, mainly because of the perceptions that the proper use of student-centered learning methods requires excessive instructor preparation time that interferes with research-related requirements; and excessive use of time in the classroom that prevents coverage of all the required course content. This paper describes how, by using a pedagogical approach known as constructive alignment[3], learning in the classroom can be significantly increased without excessive preparation time or reduction of content coverage.

Introduction

For most university instructors, among the usual duties of teaching, research, and service, research activities (writing proposals, doing the work, supervising graduate students, writing reports and papers, attending relevant conferences) usually are given the greatest time commitment. The principal reason for this is the extreme emphasis that is usually placed on research for promotion, tenure, and salary increases. As a result, the unwritten and unspoken goal for the teaching component is to do an adequate job with the least possible amount of effort and in the smallest possible amount of time. Once a set of good lecture notes has been prepared for a course, teaching via the traditional lecture, in which the instructor speaks most of the time and students mostly listen and write notes, is very time efficient; hence its popularity as a teaching method. For most instructors, good teaching means being thoroughly prepared for class (which usually requires a relatively brief review of one's notes), presenting the material clearly and logically, and monitoring students' facial expressions and questions for corrective feedback.

Regardless of how well-prepared an instructor might be, how clear his/her lectures are, or how carefully he/she observes and responds to facial expressions and questions, the traditional lecture format has two significant weaknesses[1]. The first is loss of attentiveness; educational research has shown that student learning decreases by approximately 50% every twenty minutes during a typical traditional lecture. The second weakness of the traditional lecture is that it primarily involves three of the least effective learning styles, hearing (what the lecturer says), reading (anything he writes, e.g., on the chalkboard or overhead transparency), and seeing (any figures or diagrams that might be presented as part of the lecture). Educational research has also shown that most people learn 10% of what they read, 20% of what they hear, 30% of what they see, 50% of what they see and hear, 70% of what they discuss with others, 80% of what they use and do in real life, and 95% of what they teach someone else (peer-instruction). Thus, an obvious avenue toward improving one's teaching in the lecture-based learning environment is to address these two weaknesses, which can be accomplished with the appropriate use of teaching and learning activities (TLAs) within the framework of a constructively aligned course[3]. In the following sections, constructive alignment is described and illustrated using an example from electrical circuit theory. Emphasis is placed on TLAs and formative assessment tasks and the relationship between them; and on the important difference between formative assessment and summative assessment and how to use them correctly.

Teaching and Learning Activities in the Constructively Aligned Course

In a constructively aligned course curriculum, the content or course topics are expressed as intended learning outcomes (ILOs), i.e., as things that students should be able to do upon completion of the course. For example, if the topic is nodal analysis of linear electric circuits, the associated ILO might be "At course completion, the student should be able to use nodal analysis to analyze simple linear electric circuits."

In order to facilitate the achievement of the ILOs by the students, in a constructively aligned course the instructor briefly interrupts the lecture (a pause) to provide the students with TLAs that specifically address the ILOs, i.e., activities that help them learn how to do what the ILOs require. A given TLA may address one or more ILOs, and conversely, more than one TLA may be used to address a specific ILO. Many excellent TLAs are available[1,2]. For the example of nodal analysis of electric circuits, the students might be asked to work in groups of two or three to solve a specific instructor-provided circuit problem using nodal analysis. Following that, volunteers may be given the opportunity to present their solutions to the entire class, e.g., using the chalk board. This TLA encourages the pedagogical techniques of collaborative learning and peer instruction[2]. A slight variation of this TLA would be to ask the students to work on the problem individually before working on it in small groups, a TLA known as Think-Pair-Share[4]. Other, very simple, yet effective TLAs for the lecture-based format include pauses for students to discuss what the instructor has said thus far, to compare notes, to formulate questions or list unclear points for instructor feedback, or to summarize the material of the lecture. Note that all of these TLAs (and most others, as well) are easily understood, so including a few in each lecture should pose no significant preparation-time burden on the instructor.

It is also important to note that the above-described TLAs, in which the students have the opportunity to discuss, practice, and teach each other, involve learning styles, discussed above, that result in much greater learning than hearing, reading, and seeing, the learning styles associated with the traditional lecture format of instructor speaking and students listening and writing notes. Furthermore, the pauses associated with the TLAs interrupt the above-mentioned decline in attentiveness that occurs as the traditional lecture progresses and return student attentiveness to where it was at the start of the class[1]. Thus, it is clear that the use of constructively aligned TLAs in the lecture solves the two most significant weaknesses associated with the traditional lecture.

Assessment in the Constructively Aligned Course

The final component of the constructively aligned curriculum is assessment, which has been said to actually determine curriculum because, in a practical sense, it usually determines what students will spend time learning. Assessment can be either formative or summative. Formative assessment is used to provide feedback to students and instructors for the purpose of improving learning and teaching, respectively. Summative assessment is more or less final, used to assess learning for permanent grading , without further opportunity for improvement. In a well-designed course, the assessment tasks simply and specifically address the learning outcomes.

If the TLAs in the lecture-based format are properly aligned, some of them can double as appropriate formative assessment tasks. In the electric circuit analysis example, after students have worked on the problem, whether alone or in small groups, and after presenting their solutions to their peers, the lecturer can provide his/her solution or comments on the students' solution, which should then be used by the students to improve their learning of the subject, i.e., achievement of the ILO or ILOs in question, and be better prepared for a later, final summative assessment. Furthermore, the students' solutions as presented to their peers, e.g., on the chalk board, provide the instructor with feedback on how well the students are learning. Another excellent form of formative assessment in the lecture-based format is the "homework" assignment, in which students do tasks, e.g., solve circuit analysis problems, outside the classroom and submit them for individual instructor assessment. To be effective as formative assessment, the submitted work should be carefully corrected with sufficient comments that the student can use constructively to improve learning.

A third popular example of formative assessment, which is especially appropriate for large lecture-based classes, is the use of learner response systems (LRS), known commonly as clickers. Associated with a given ILO, the instructor uses as assessment task a relevant multiple-choice question. The students take a minute or two to determine and submit an answer via the LRS which, through the LRS software, provides the instructor with immediate statistics on the student responses. This provides the instructor with feedback on how well the students are learning. He or she may then optionally ask the students to work in small groups to compare and discuss their responses to the question and re-answer it. This opportunity for in-class peer instruction usually results in improved student learning.

Summative assessment in lecture-based modules is usually associated with "points" or "marks" that accumulate and are used to determine a student's final "grade" in the course. In engineering, the most common summative assessment task is an ILO-associated question or problem on an examination, given either at the end of the course or at a point in the semester after which the ILO in question will no longer be revisited. Other summative assessment tasks include written laboratory reports (if the module includes a laboratory component) and written papers, perhaps on ILOs covered independently by the students.

Some assessment tasks, such as homework assignments or questions on midterm examinations, are often used both formatively and summatively. That is, they are graded and returned to the students with formative feedback, but the grades are saved for use in determining the students' final, permanent grades at semester's end. This is a questionable practice because, whereas with formative assessment tasks the students should be encouraged to try new things, i.e., risk making errors in anticipation of the formative, corrective feedback, with summative tasks they cannot risk making errors due to the finality of the assessment. Thus, assessment tasks used both ways simultaneously lose the formative advantage of risk.

Discussion and Conclusion

It has been argued here that the use of constructively aligned TLAs and formative assessment tasks (student-centered learning methods) pose no additional preparation-time burden on the instructor, and that they correct the weaknesses of the traditional lecture format by interrupting the loss of attentiveness and using more efficient learning styles than hearing, reading, and seeing. Concerning the objection by instructors that using TLAs and formative assessment tasks in the classroom is time-consuming, thus making it impossible to cover all the required content, note that all course content is not equally difficult to learn or even important; thus, the ILOs for the course can be prioritized, and those that address the less difficult or less important content can be addressed by the students working independently and collaboratively using appropriate TLAs. Examples of such TLAs include reading assignments, on-line practice questions, and written reports and papers. Thus, every instructor, no matter how busy with other duties, should be able to include student-centered learning activities in his or her lecture without excessive time investment or reduction in content coverage.

Bibliography

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Biographical Information

Robert O'Connell received the B.E. degree in electrical engineering from Manhattan College and the M.S. and Ph.D. degrees in electrical engineering from the University of Illinois. He is a Professor of Electrical and Computer Engineering at the University of Missouri-Columbia and a registered Professional Engineer. He recently completed a Fulbright Fellowship in the School of Electrical Engineering Systems at the Dublin Institute of Technology in Dublin, Ireland, during which he studied modern teaching and learning methods for engineering education, including student-centered and group-based learning.