# AC 2000-116: Dealing with Difficult Lectures

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# Dealing with Difficult Lectures

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Abstract

Lectures are a time tested structured educational materials delivery tool.(1) They also provide an educator a means to manage the transmission of course curriculum and concepts.(2) Lectures are adaptable but different when used in courses throughout an entire engineering program.(3) However, a critical component in the task of educating via an effective lecture is the lecturer's recognition of the facts that difficult lectures exist and that they must be carefully dealt with. Difficult lectures are ubiquitous in all traditional 4 and 5 year undergraduate engineering curricula. They can be found in courses from the beginnings in calculus and college physics to the final courses on the most advanced topics.

Difficult lectures do not always deal with difficult topics. However, difficult topics are always difficult lectures. The proper development and subsequent successful delivery of a difficult lecture or series of lectures imposes an initially simply-phrased demand upon the lecturer, i.e., the lecture must be acknowledged as difficult by the lecturer. This is especially important for educators who present engineering and engineering science topic lectures.

This paper will explore and define some of the common attributes of difficult lectures. It will also contrast these attributes to those common defining "easy" lectures found in engineering courses. Finally, it will offer suggestions for identifying possible difficult lectures in engineering course material, so that a faculty member may adequately prepare for its presentation to a class.

## Easy Topics that Lead to Difficult Lectures

Difficult lectures sometimes occur with relatively simple topics. The seasoned lecturer will recall times when students obviously had difficulty with a topic the lecturer perceived as straightforward or perhaps repetitious of earlier material. The challenge for the lecturer is to anticipate places in the course where these situations are likely to be an issue and prepare to address them as they occur throughout the course. The difficult situation is compounded when the lecturer does not understand the root cause of students struggling with easy material. Both students and instructor become frustrated.

One of the most frequent situations that students think of as difficult is when they view the topic as separate from the rest of the course. In these instances, students do not see the relevance to the material because they are not familiar with the big picture, nor do they understand why the topic is needed or how it will be integrated with the main subject of the course. Fortunately, these topics are easy to identify for the instructor and the fix is not time-consuming. For example, a topic that appears in an Appendix of the textbook almost always falls into this category. The instructor during the preparation of the course syllabus can identify other examples by recognizing topics that set the stage for subsequent material. The obvious solution to this type of difficult lecture is to state the motivation for spending time on the topic. Sometimes it is appropriate to give them the punchline first and then delve into the details afterwards. The students are more likely to follow the development if they have a sense of its importance so reiterating the motivation at the end of the coverage, or demonstrating the necessity for the new topic through an example mitigates the problem.

Topics that are repetitious in the fundamental theory but extend the range of problems that can be tackled can be difficult for students, particularly if the students do not have a firm grasp of the theoretical underpinnings. Engineering courses that introduce a concept in one-dimension before addressing either a two-dimensional or three-dimensional view do so to develop a foundation of understanding. The challenge to the lecturer is to present the rationale for extending the theory, to illustrate the new complexities that result from the increased solution space, and to reinforce the prior content. This latter point is best handled when covering the first basic topic by identifying its limitations and preparing the students for the next step. This approach can continue with each of the advanced but repetitive topics. Reminding students of the development will help them distinguish between the similarities and differences.

Design courses present different challenges with regard to simple (but difficult) lecture topics. Invariably design courses will include open-ended design projects. Certain topics, like design methodologies and concept development, are standard and repeated regardless of the design project. Other topics are specific to the particular design project and would not be delivered each time the course is offered. For these, the topics may be difficult because the may be outside the realm of expertise of the instructor. That is not to say they are complex, but rather unfamiliar. Consider, for example, a project that requires the design of a fiber optic amplifier housing in a course where neither the students nor instructor have had prior experience in the fiber optic industry. To set the problem in the proper context, the lecturer may wish to give some background on the industry, the history of fiber optics, or fiber optic manufacturing. This supplementary information is usually broad and while it may be unfamiliar, it is not complicated. The key to presenting this material is to find resources that fit the level of interest and need. The resources may be personnel (a guest speaker), or textual (articles from technical magazines, or relevant chapters in introductory texts).

Difficult Topics that Lead to Difficult Lectures

Difficult topics are always difficult lectures. The trick is to quickly recognize a difficult topic so that the lecture can be structured to rise to the occasion. There are several impediments to achieving this level of recognition. A subtle but fundamental hurdle is the fact that the gage for lecture difficulty is referenced to a sliding scale. This scale is biased by the instructor’s own knowledge base as well as biased by the instructor’s perception of the students’ background.

Instructors must undertake a candid, substantial and extremely honest evaluation of their own knowledge of the subject matter. This evaluation is essential to avoid two pitfalls. The first is the possibility that the instructor is too familiar with the topic. This dichotomous situation, where the lecturer’s expected high knowledge content is the source of a potential problem for the lecture, stems from the fact that lecturers may tend to translate personal familiarity as topic simplicity. If this situation does occur then the lecture will be too difficult for the class. It will enter the subject area at a comprehension level that is above most of the students and end with performance expectations beyond all of the students. It is a lecture doomed to fail before it even begins. Plus, it will stigmatize the topic as being too difficult and therefore of minimal value from the student's perspective. The irony of this situation is the fact that this all can happen transparently to the lecturer.

The second pitfall with respect to the lecturer's knowledge of the subject matter develops when lecturers do not recognize their own limitations with the subject matter. If this happens, the instructor is not intrinsically comfortable with the topic but perceives or believes that the topic should be easy for others. This flirtation with arrogance is always a recipe for disaster since the student is the ultimately the one that ends up dealing with the material on the wrong plane and from the wrong point of view. Again the results are predictable and exactly the same as above.

The lecturers' burden to recognize difficult lecture material is not removed even when their assessment of their own knowledge base is correct. The lecturer must also accurately assess the attributes of the class. These class characteristics include the student's preliminary knowledge base with the lecture topic area and their attitude toward the lecture material. If the lecturer overestimates the student's skill set the lecture will be intrinsically too difficult independent of the material complexity.

With respect to judging class attitude, a student's expectation for the lecture may not be in tune with those of the lecturer. This situation could commonly develop in upper level classes. By this time, for example, students have developed a strong set of applications orientated heuristics. After many courses and countless homework assignments focusing on specific applications of innumerable theories, it will be very difficult for a lecturer to deliver high content presentations that are designed to explore a theory. At this point, the students are not interested in the theory. Nor do they perceive that theory has any stand-alone value. They just want to see applications.

In this situation, the lecturer must do some pre-lecture "PR". The students must be sold on the idea that the theory to be discussed in the forthcoming lecture is important as a stand-alone engineering topic. If the student is not convinced that the material should be studied for its own sake, then the lecture will fall into the difficult category because it will have no perceived relevance. Unfortunately, in this situation this poor coupling of lecturer and lecture does not just produce a difficult lecture, it may also produce a hostile audience. This, in turn, amplifies the perception of difficulty of the lecture material.

Of course, the other major impediment to identifying a difficult lecture is to actually recognize that the topic is intrinsically difficult. In general, it should be expected that lectures that deal with integrated topics are going to be difficult for students. This is true no matter how well prepared the students happen to be. It is simply difficult for students to synthesize information from their various courses. Lectures that demand recall of previous knowledge and/or different skills to understand the current lecture topic are always demanding of the student. Therefore, the lecturer must recognize this difficulty level and not only be prepared to, but plan to implement various ploys that help the students bring the necessary components together.

Fundamentally, this means that the lecturer has to slow down, review and repeat. It does not mean that the lecturer has to "baby" the class. The expectations from the lecture remain high. The synthesis exercise remains undiluted. The impact on the students' thought processes must be substantial. However, the lecturer does spend time and energy during the lecture to facilitate the students' new integration experiences.

Another lecture type that is assuredly difficult for students deals with material that does not enjoy the luxury of a single solution path to the right conclusion or answer. Students are traditionally used to lectures that drive home a single point. They can even cope with lectures that drive home a difficult point. However, they are never initially prepared to become involved with a lecture in which the topic offers multiple options. This is specifically true when a lecture has to be developed with parallel option paths. They would much rather examine an answer for validity than evaluate the merit of the path to the answer. Simply stated, students don't like to work open-ended problems nor do they like to listen to open-ended lectures. Both open-ended experiences are just too difficult.

Lectures can also be classified as difficult when they contain components that are by nature difficult for students. Such components are embedded in integrated and open-ended lectures as well as lecture topics that should be considered straight forward or even easy. Some of these components are math elements such as (a) second order differential equations; (b) imaginary planes; and (c) visualization of large matrix operations. Other include (a) the use of unfamiliar science vocabulary or concepts; (b) the notion of unsteady state behavior; and (c) the application of poles and zeros. In all situations where these components exist, the overall lecture will be at best will be confusing until they have adjusted their frame of reference for the material to include the necessary difficulty.

Summary

This paper identified two classes of difficult lectures, discussed when they appear in courses, and suggested approaches for preparing and delivering difficult lectures. Refer to Tables 1 and 2, which summarize the various scenarios.

It is not an easy task for any classroom teacher to evaluate course material from the perspective of a student who begins a course essentially with "tabula rasa". Not only do the students have no background on the topic, but they also do not have the significant experiential or related peripheral knowledge that make learning a new subject easier. Recognizing the root cause of the difficult topic is the first step in seeking the best way to present it to the class. Anticipating where and why students have difficulty and preparing appropriately are critical elements for the lecturer to make the most from the limited classroom experience.

TABLE 1. Difficult Lectures with Simple Content

| | Situation #1 | Situation #2 | Situation #3 |
|---|---|---|---|
| Problem | The connection of the topic to the rest of the course is not obvious | The topic is repetitious but includes extensions that expand the application | The instructor is marginally familiar with the topic and recognizes the importance of providing an overview to achieve a larger course objective. |
| Example | Topics that support other course topics, such as moments of inertia in fundamental engineering mechanics courses like Dynamics or Strength of Materials | Problem solving procedures that are first introduced for 1-D problems, followed by 2-D and 3-D problem, such as static equilibrium in an introductory physics or mechanics course | Technical topics related to a design problem where the design methodology is the main emphasis of the course and the technical topic is necessary to familiarize students with the related industry |
| Suggested Approaches | a. State the relevance of the topic to the course before beginning the topic coverage and reiterate its importance afterward.<br><br>b. Demonstrate its importance with an example that links the topic to other course elements | a. Provide a recap of the previous approach and have students identify what complications the new dimension adds to the solution method. Use that discussion as a springboard into the expanded method.<br><br>b. Emphasize the expanded capability and the enhanced applications<br><br>c. Identify the limitations so that when the next dimension is added, the students will see the benefit of building on the prior foundation | a. Invite a guest lecturer who is familiar with the industry<br><br>b. Devote a class in which students identify the topical areas that will be most important for them to understand when addressing the design project. Use their suggestions to frame an overview lecture<br><br>c Identify a good introductory text on the topic, summarize the main points, and make the text available for student reference |

TABLE 2. Difficult Lectures with Difficult Content

| | Situation #1 | Situation #2 | Situation #3 |
|---|---|---|---|
| Problem | The lecture must deal with the details of a difficult theoretical topic | An integrated topic must be taught where many different engineering, science and social studies disciplines must be brought together quickly and melded together to solve a specific engineering problem | The difficult problem type that must be covered in the lecture is open-ended, with several solution paths to the same answer |
| Example | The optimization of a recycle system in an autocatalytic reaction, in an environmental or chemical engineering reactor course | Typical examples can be found in most ABET type capstone design courses in each discipline. These might include site development, plant design, etc | Truss analysis in Statics courses often offers the first glimpse of alternative solution paths |
| Suggested Approaches | a. Use pre-lecture "PR" to set the stage that the upcoming lecture on theory behind the analysis is essential to particular and important applications<br><br>b. Mention and briefly discuss applications during the lecture on the theory<br><br>c. Follow up the theory lecture with an applications lecture of the theory, stressing the theory during the application | a. Take time to introduce the more remote, less familiar topics in class providing some beginning references to help the students catch up in these areas<br><br>b. Be prepared to employ any ploy to bring the various parts of the design together<br><br>c. Emphasize (and illustrate, if possible) the fact that these types of problems have many ways to begin solution, and that the method chosen is usually the one the individual is most comfortable with<br><br>d. Stress that there are often many "correct" answers, even when the design constraints are very tight (i.e., in school) | a. Clearly outline the various options, and work through at least 2, or provide the solution paths<br><br>b. Offer the students time in class to identify a solution path and explore it during the current, or next lecture, illustrating why it is appropriate or not<br><br>c. Take time to compare the results of different solution paths after they have been reviewed in class. Discuss the options for efficiency, soundness, accuracy, or any appropriate qualifier |

## References

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