

**AC 2009-1369: COMPARING THE LECTURE METHOD WITH THE
CASE-TEACHING METHOD IN A MECHANICAL ENGINEERING COURSE**

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Comparing the lecture method with case teaching method in a mechanical engineering course.

Abstract

As engineering education has moved from didactic instruction to more learner-centered methodologies, new and innovative techniques are being used to teach students¹. In this paper, we present results from a study conducted in two mechanical engineering courses at a large mid-western university on the influence of case-based instruction on students' attitudes and beliefs on their own learning and engagement when compared to the traditional lecture method.

Specifically, participants completed a nine-item survey comparing the two teaching approaches.

The data produced mixed results as the majority of participants felt they were more engaged and active when case teaching method was used, but felt they learned more from the traditional lecture method.

I. Case-based Instruction

Case-based instruction has its roots in legal education, where it has been used for over a century to portray the complex and ill-structured nature of real world issues¹. Other professional fields (such as, medicine and business education) have also adopted case-based approaches to help students deal with the dilemmas and uncertainties presented in their complex profession². Case studies promote an active style of investigation that helps students to better succeed in the "real world"³.

Barrows highlighted that problem-based learning methods, such as case-based instruction, help students acquire knowledge rooted in the discipline and develop problem-solving skills³. In addition, the use of case studies has been hypothesized to increase student engagement, motivation, and participation in classes. A national survey of science faculty

perceptions on the benefits of cases found that faculty think case studies improve students' critical thinking skills, encourage the development a of deeper understanding of concepts, enhance student engagement, and allow students to take an active part in the learning process ⁴.

Richards and colleagues proposed the use of cases in engineering education because cases help to make the curriculum relevant, motivating, and active, while pushing students to integrate the concepts they have learned with other experiences ⁵. Overall, case-based instruction has been used in numerous ways in the engineering field with encouraging results ⁶. However, more research needs to be conducted to examine the influence of case-based instruction on students' learning and engagement. The purpose of this study was to examine student perceptions of the influence case studies on their own learning and engagement.

II. Methodology

A. Participants

Eighty-six students enrolled in two sections of a systems modeling mechanical engineering course participated in this study. All participants were juniors in the Mechanical Engineering program at a large mid-western university.

B. Materials.

Case Studies.

The authors developed two case studies based on actual events that related to the two topics at hand (i.e., hydraulics and thermal systems).

Hydraulics Case Study. The hydraulics modeling was presented via a case study of human fatalities resulting from two catastrophic failures of hydro-electric dam penstocks due to a dynamic phenomenon call "water hammer". The case study discussed how mathematical models can predict this phenomenon and provided insight as to how it can be avoided.

Thermal Systems Case Study. The case study covering thermal systems focused on the Three Mile Island nuclear power plant disaster. After a brief overview of the plant and its history, a timeline of the events on the day of the partial reactor meltdown was covered. The case study was accompanied by technical details to allow students to conduct thermal calculations to help explain the events of Three Mile Island.

Survey.

Participants completed a nine-item differential scale survey to assess their perceptions of benefits of using case studies. Specifically, the survey asked participants to compare case teaching method with traditional lecture along nine dimensions related to their learning and engagement. The survey was adapted from previous research conducted by Yadav ⁷.

C. Procedure

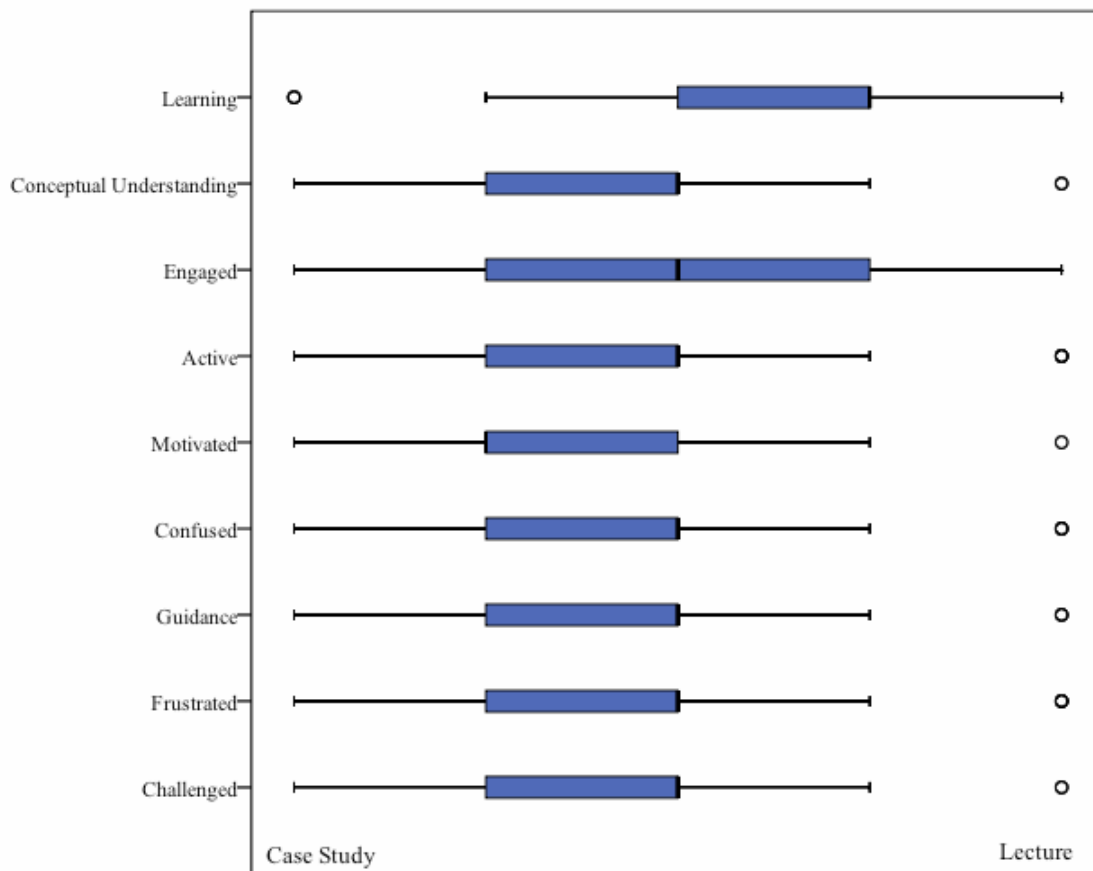
The study utilized a counterbalanced design, where two topics (thermal vs. hydraulic systems) and the method of instruction (case study vs. traditional lecture) were counterbalanced. Specifically, instructor A taught thermal systems topic with case studies while instructor B taught the same topic using traditional lecture. This was reversed for the hydraulic systems topic so that instructor B taught using case studies and instructor A taught using traditional lecture. Participants anonymously completed the survey at end of the course.

III. Results

The survey results suggested that majority of the participants felt they learned more from the traditional lecture method (57%) as compared to case study (23.3%) and developed a better understanding of concepts from the lecture method (41.9%) vs. case studies (33.8%). However, it is interesting to note that students felt they were more engaged during case study teaching (52.4%) as compared to traditional lecture (10.4%) and they were also more motivated when

using case studies (48.9% vs. 15.1% for traditional lecture). Students also reported that they were more active when using case studies (38.4%), while only 9.4% felt more active during traditional lecture. Figure 1 presents these results graphically (See Appendix A for a detailed descriptive statistics).

Figure 1. Comparing the case study method vs. traditional lecture method



IV. Discussion

Results from this study suggest that students felt the use of case studies allowed them to be more engaged in the course and take an active role in their own learning. However, it is interesting to note that even though students felt more active, and engaged when case studies were used, they felt they learned less from case studies and developed a better understanding

from traditional lecture. This was particularly surprising, as one would expect student perceptions on both their learning and engagement to match. One hypothesis for this disconnect between student attitude towards their own learning and engagement with case studies could be a result of how student learning was measured. Even though instructors used case studies, the quizzes and exams still assessed student learning using traditional measures, such as multiple-choice questions, mathematical modeling, etc.

Case teaching method focuses on depth of understanding rather than the breadth and has been hypothesized to increase students' critical thinking and problem-solving skills. Lundeberg and Yadav highlighted that to measure student learning and conceptual understanding from case studies requires a careful construction of measures ⁸. Hence, the way student learning was assessed in the course and given that students completed the survey at the end of the course might have influenced what they thought about their own learning from case studies.

The results from this research are limited because the case studies were implemented for only one topic each in the two courses. Future research on the influence of case studies on students should be implemented over a longer period of time. Another limitation of this study is that we only examined student perceptions of their own learning and engagement, and did not actually assess their learning. Future research should develop measures of learning relevant to case study method (such as, open-ended questions) as alternatives to performance data (such as, multiple-choice questions) ⁹.

V. Conclusion

Case-based instruction has been found to increase student engagement, motivation, participation, and learning ³. In this study, student perceptions of case study method partially support this research as students felt that case studies led to more engagement and motivation, but did not

lead to better learning. These results suggest that case teaching method has the potential to engage students in the course content as students who switch out of science discipline report poor teaching as one of the main reasons for switching out ¹⁰. However, this paper did not examine actual measure of student learning and only reported their perception of learning. Future research needs to specifically examine measures of student learning by using “methodologically sophisticated, qualitative methods such as, interviews, journals entries, observations, and case studies of particular students as alternatives to standardized objective tests or constructed case analysis tests” ⁸.

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Appendix A: Comparing the two methods – Case teaching method vs. traditional lecture method

Learned More

	*	*	*	*	*	
Case Study	4.7%	18.6%	19.8%	33.7%	23.3%	Traditional Lecture

Developed a better understanding of the concepts

	*	*	*	*	*	
Case Study	4.7%	29.1%	24.4%	19.8%	22.1%	Traditional Lecture

Was engaged

	*	*	*	*	*	
Case Study	19.8%	32.6%	37.2%	8.1%	2.3%	Traditional Lecture

Was challenged

	*	*	*	*	*	
Case Study	5.8%	25.6%	45.3%	16.3%	7.0%	Traditional Lecture

Was motivated

	*	*	*	*	*	
Case Study	10.5%	38.4%	36.0%	8.1%	7.0%	Traditional Lecture

Was active

	*	*	*	*	*	
Case Study	5.8%	32.6%	52.3%	4.7%	4.7%	Traditional Lecture

Was frustrated

	*	*	*	*	*	
Case Study	12.8%	16.3%	58.1%	7.0%	5.8%	Traditional Lecture

Needed more guidance from the instructor

	*	*	*	*	*	
Case Study	16.3%	29.1%	37.2%	14.0%	3.5%	Traditional Lecture

Was confused

	*	*	*	*	*	
Case Study	11.6%	22.1%	54.7%	8.1%	3.5%	Traditional Lecture