A Preliminary Investigation into the Use of Audience Video Recordings to Assess Student Engagement During in Large Lecture Classes

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Abstract

Twenty-first century higher education is moving from a faculty-centered teaching model to student-centered learning. With this change the question has become are the students learning? This study presents a method for direct, authentic, and formative assessment of the student engagement level during various lecture techniques in large classes. The basis for this study is that student engagement leads to student learning. Video recordings of a 208-student capstone lecture audience were assessed for five different lectures using an ordinal scale. Three different pedagogies were explored: traditional lecture, active-collaborative learning (ACL), and random calling to see if they have an effect on the average level of engagement during lecture. It was shown across 59 data points that ACLs lead to a significant increase in engagement while there is no meaningful difference between traditional lecture and random calling especially when compared to ACLs.

Keywords

Active-Collaborative Learning, Assessment, Pedagogies, Student Engagement

Introduction

Classrooms, especially at the university level, have traditionally been instructor-centered. In this passive learning environment students are responsible for their own engagement and participation while the lecturer presents information to the class, hopefully in an engaging manner. As the millennial generation has entered higher education they have also brought with them a desire for active, student-centered educational experiences. Organizations such as the Kern Entrepreneurial Engineering Network (KEEN) have spawned dialog amongst educators about the different teaching pedagogies that comprise student-centered experiences and their efficacy in the classroom towards the creation of an Entrepreneurial Mindset. In KEEN terminology the mindset consists of curiosity, connections, and creating value to accompany the traditional engineering skillset.

At the core of a student-centered learning experience are the active-collaborative learning (ACL) teaching pedagogies. K. A. Smith et al.[1] termed these the *Pedagogies of Engagement.* In his paper the connection between engagement and learning is chronicled with various collaborative pedagogies having positive effects on student exam performance. A fundamental assumption of this study is that zero student engagement leads to near-zero learning. It is then asserted that engaging students increases the probability that they will learn something from their time in the classroom. Studies published concerning the effect of ACL activities on student engagement during lecture have, to the author's knowledge, used indirect measurement techniques. These mainly consist of student self-evaluation using surveys like the work of P. Armbruster et al.[2] and comparative performance on exams and other activities as with M. Moravec et al.[3], for example. The impact of ACL on student exam performance and failure rates has also been explored by S. Freeman et al.[4] who used meta-analysis of existing studies, similar to those listed, to demonstrate the advantages of ACL, in general, over traditional lecture.

This paper addresses the following question: Can the impact of active-collaborative learning on student engagement be quantified so that these methods may be further studied and improved? Audience video recordings from lectures are used to provide direct, authentic, and formative assessment of the impact of lecture activities on the level of student engagement in a classroom. Student engagement is studied during 1) active learning, 2) active-collaborative learning, and 3) traditional lecture. The method uses five lectures from four different presenters in the Technical Entrepreneurship (TE) Capstone course at Lehigh University. The hypothesis for this study is stated as: "the use of Active-Collaborative Learning techniques causes a significant increase in the average level of student engagement during a lecture when compared to traditional lectures." Moreover, it is the collaboration aspect of ACL that leads to improved engagement and therefor improved efficacy in student learning.

Methodology

The Technical Entrepreneurship capstone course is Lehigh's ABET required design experience for Mechanical Engineering, Bioengineering, and Material Science and Engineering students at Lehigh University. TE Capstone is interdisciplinary by also including students from Supply Chain Management in the College of Business and Economics and Art, Architecture, and Design in the College of Arts and Science. It is taken by second-semester Juniors (TE 211 – 3 credits) then first semester seniors (TE 212 – 2 credits). For the 2017 project year there were 208 students in the class divided into 31 interdisciplinary teams of 6-7 working on 25 industry sponsored projects. The overall course objective is to have students develop a customer driven technical solution to a real-world problem in a business context through the application of an entrepreneurial mindset accompanied by their engineering skillset.

TE 211 has two 75-minute lectures per week on the Integrated Product Development (IPD) process utilized throughout the course. Subject-expert guest lecturers are also invited to present key topics such as industry standards and risk mitigation. Lectures were recorded using the in-room distance education video system and Panopto recording software to allow students to review lectures online. The student audience was also captured in this video feed and the existing video footage from the spring 2017 semester was utilized for this study.

The course was taught in a large lecture auditorium with 263 seats arranged in 3 sections. Only the first six rows (A-F) of the middle column of seats (1-13) were evaluated during the study due to the camera's limited field of view and maximum image resolution of 1280x720 pixels. Figure 1 shows a snapshot from the camera during a regular lecture. The 78 seats in the front (A1-F13) comprise the region of study. The third section of seats is located to the left of those pictured. Teams were randomly seated with their teammates across the rows. This eliminates the self-selecting factor of student engagement in the front row of class. On average, 22.21% of the seats in the region of study were empty during lecture.

Three different lecture styles were evaluated. First, the control case was continuous lecture using PowerPoint slide presentations. The second lecture style employed two active-collaborative learning methods called minute papers and think-pair-shares. Third was a class-wide random calling discussion of the current lecture. Multiple lecture formats were also studied. The control was an un-interrupted lecture followed by an ACL and random calling at the end of class. A sandwich-style implementation was also studied where ACLs such as a think-pair share were used at the start and end of class with an un-interrupted lecture in the middle. Lastly, in two lectures multiple ACLs were interwoven within short blocks of lecture. Random calling utilized a random name generator to select either a student or team to participate in a discussion with the instructor. These generally followed an ACL activity where the individual team outcomes were presented for the benefit of the entire class.

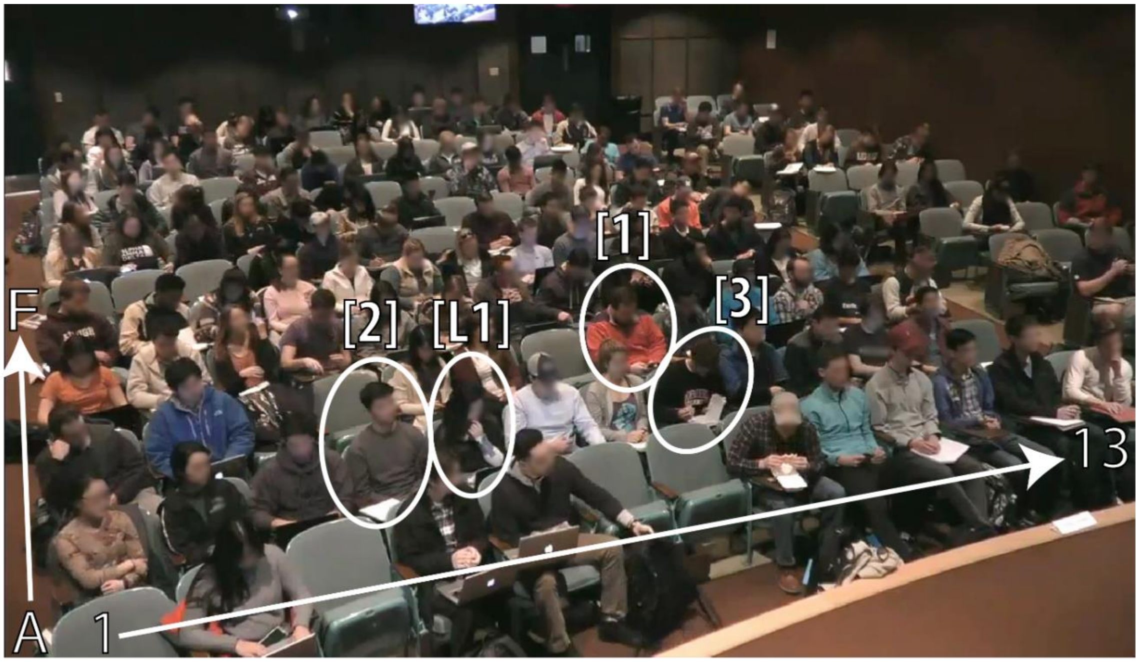

Figure 1: Image of audience taken by video recording system during traditional lecture potion of control lecture. Seats A1-F13 were evaluated as part of the study. The [#]s are the ordinal values assigned to each student

In total, 59 video clips 20-30 seconds in length were analyzed from the five lecture recordings. Data points were selected such that they were spaced throughout the lecture and contained a single activity (e.g. the lecturer talking, a random-calling activity, or an active-collaborative learning activity). Each clip was played on repeat and the engagement level of each student in the region of study was assessed using an ordinal scale from 1-5 based on a modified version of the Behavioral Observation of Students in Schools (BOSS)[5] system. Table 1 lists the criteria developed by Associate Investigators (AI) Davis, Wright, and Swagat that were refined by Principle Investigator (PI) Bilsky. Students with laptops were assigned a laptop corrected score of L1-L5 based on the likelihood the laptop was being used for course related work rather than as a distraction. The average engagement was calculated by taking the mean ordinal score assigned to each of the 78 seats at every data point. Empty seats were considered null values and disregarded during the averaging process. Four example evaluations are the bracketed numbers within Figure 1. The [1] student is texting on their cell phone. [2] is looking at the lecturer but is not taking notes unlike student [3]. The [L1] is looking un-interrupted at the screen of their laptop. This process was followed for each of the 78 seats in the region of study.

Table 1: Ordinal criteria used to assess student engagement during lecture with adjusted score for students on laptop computers

Score	Criteria	Laptop Corrected Score
1	**Zero Engagement:** Student is sleeping, doing work for another class, or looking at phone/computer without interruption. No apparent motion	**L1:** 1.1
2	**Weak Engagement:** Student appears to be looking at lecturer but is not taking notes or demonstrating an interest in the lecture	**L2:** 1.33
3	**Average Engagement:** Student is halfheartedly participating in class discussion, taking notes 50% of the time, or half observing the lecturer	**L3:** 2
4	**Strong Engagement:** Student is actively participating in lecture or activity by discussing with neighbor (when appropriate) and/or continuously taking notes/writing	**L4:** 2.5
5	**Complete Engagement:** Student is fully participating in discussion, dutifully taking notes, or closely observing lecture without interruption	**L5:** 3

Results and Analyses

Each point on the plots in Figure 2 represents the average engagement level of the room at the time the data point was measured. The two control lectures were given by two different guest lecturers (Figure 2a). In both cases the level of engagement remained relatively constant during lecture with a significant increase during ACL activities shown by the outlier spikes in data. A third guest lecturer provided the sandwich style lecture (Figure 2b) where again there was a significant increase in student engagement during the ACL activities (spikes) when compared to traditional lecture. Two more lectures using a repeating style of ACL, random calling, and lecture spaced throughout the class were evaluated for a forth lecturer (Figure 2c) also show the ACL increase.

Evaluator Consistency: Initial evaluations of the lecture videos were performed by the three-undergraduate senior Associate Investigators (AI). Each analyzed a different lecture video by Lecturers A, B, and C assessing the level of student engagement at a total of 18 points. The use of different investigators to led to varying engagement results due to individual bias in the use of the ordinal criteria. This phenomenon was measured for the three initial lectures (two Controls and one Sandwich) by investigating the difference between engagement levels measured by Bilsky and

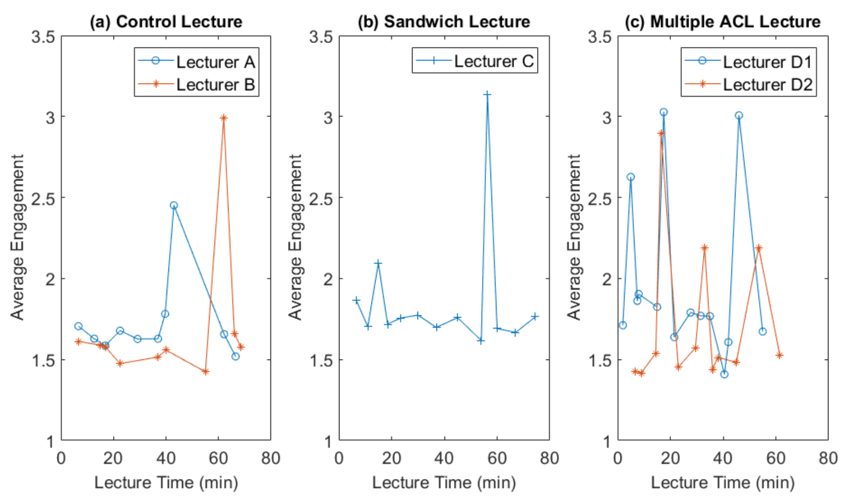

Figure 2: Average student engagement versus lecture time for (a) control un-interrupted lecture followed by ACL and random calling, (b) un-interrupted lecture sandwiched between ACLs/random calling at start and end of lecture, and (c) Lecture comprised of alternating ACLs, lecture, and random calling.

the 3 AIs. Average engagement results during the lecture-only portions were normalized to the highest recorded value for each group and investigator. There were significant differences between AI 1-3's and the PI's datasets as determined using 1-factor ANOVAs on a lecture by lecture basis (p = .6719, p=.7429, and p=.06, respectively). Figure 3 shows the normalized average student engagement values for the three lectures as calculated by AIs 1, 2, and 3. The PI's measurements for the same 3 lectures combined are also displayed. This confirmed the need for standardization across all assessments. Thus, only using data collected by PI Bilsky was used for all study results collected and discussed henceforth.

Lecturer consistency: The five lectures being analyzed were delivered by four different presenters. It was demonstrated using a 1-factor ANOVA that despite the different lecturers there was no significant difference in the average level of engagement during the lecture-only portions (p=.0206) as illustrated in Figure 4. The primary course instructor, who also delivered two of the lectures, was present and participated in all random calling and ACL activities. Based on these facts, the data from all five lectures was analyzed as one dataset for the study despite having different presenters.

Hypothesis Testing: Three more 1-factor ANOVA tests were performed on the data to test the research hypothesis. The first test showed that there is no significant difference in the average level of student engagement between traditional lecture and random calling (p=.1289). Next, the tests showed that there is a statistically significant increase in average level of student engagement when compared to both random calling and traditional lecture ($p=1e^{-7}$ and $p=8e^{-17}$, respectively). These results are shown in Figure 5.

Discussion of Results and Conclusions

Reviewing the collected lecture data plotted in Figure 2 for the five lectures shows that the level of engagement remains relatively constant during traditional lectures. During ACL activities there is a significant increase in student engagement however no significant increase in engagement was measured for random calling activities. The use of laptops and cell phones during class pose a challenge for quantifying the level of engagement. From subjective observations during lecture and while encoding data it appears that when not being explicitly used for an in-class activity they

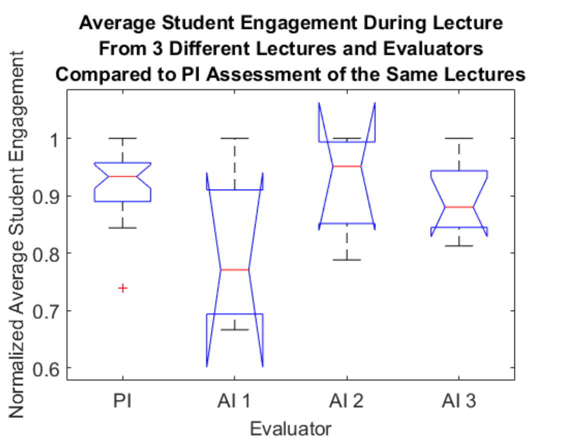

Figure 3: Normalized average level of student engagement during lecture as measured by 3 associate investigators (AI) for three different lectures. Principle investigator's (PI) assessment is also displayed

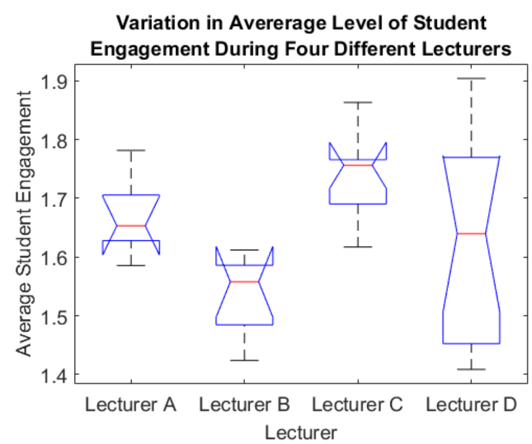

Figure 4: Average student engagement level during lecture-only portions of five lectures delivered by four presenters. Lecturer D presented two of the five

tend to be distractions. Cell phones appeared to be a larger distraction even in the front rows of the lecture. Without knowing what each device is being used for the investigators were forced to take a pessimistic view when assigning an ordinal value to students using these devices.

This study has in many ways raised more questions than it has answered. It has been shown that in a large lecture format collaborative active learning techniques, specifically think-pair-shares and minute papers, have a direct effect on increasing the average level of student engagement during a lecture. Likewise, random calling offers little to no increase in engagement over traditional lecturing. It is necessary to see how the results from a similar study performed in other courses of different sizes and lecture formats compare to those presented here before making larger, more general statements about the efficacy of ACL on increasing student engagement.

Further studies should explore a variety of class sizes and in core STEM courses rather than capstone since it is unique by not having exams or explicit homework problems but rather project deliverables and presentations. Exams carry with them an implicit burden that weighs on students and may cause them to behave differently during lecture. Researchers continuing this work can hopefully answer these questions with more observations and better cameras more strategically placed. Future, more extensive work should be able to explore if engagement varies over time and the effect ACL activities on these trends.

In conclusion, the use of video recordings of lecture audiences has been shown to be an effective method for direct, authentic, and formative assessment of student engagement during large capstone lectures. The initial hypothesis that active-collaborative activities increase engagement over traditional lecture has been validated. Random calling demonstrated no significant improvement over un-interrupted lecture indicating that in-class activities should focus on being both active and collaborative to best engage students.

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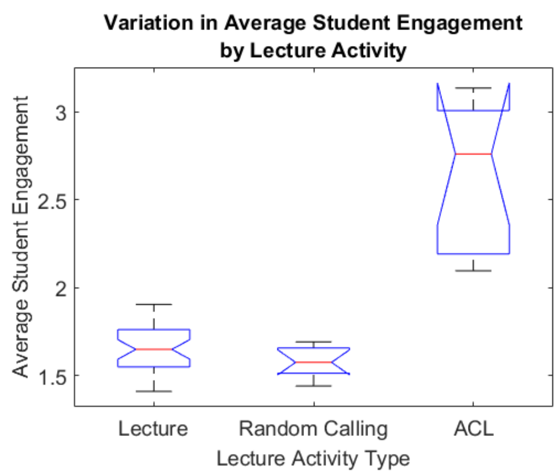

Figure 5: Variation in average student engagement during regular lecture, random calling activities, and active-collaborative learning (ACL) activities

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