Student Experiences with Active Learning Across Course Delivery Modalities

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Abstract

Background: Methods for the delivery of instruction in the engineering classroom have been shifting at an increased rate over the past few years due to several factors. Pedagogical approaches which have seen increased growth in adoption include the use of online delivery, for full courses or for portions of a course, pre-recorded preparatory material, and active-learning activities. According to the literature, students generally appreciate the use of active in-class experiences where there is ample time for asking questions and solving problems. *Method:* In this paper, I examine student perceptions of the use of a flipped-classroom approach with high levels of active-learning. I compare these perceptions across variations in course delivery (online and in-person), curriculum level (introductory and advanced), and laboratory setting (laboratory intensive or not). Students were surveyed using both qualitative and quantitative questions to compare across courses and across semesters where variations in delivery modality and course level occurred under the same single instructor. *Results:* The results of these survey instruments include a summary of the survey responses broken down across the three variations mentioned. Disambiguation of these results is limited due to the interrelations between each factor. *Conclusions:* The primary finding is that while students showed some preference for in-person course delivery and a laboratory-intensive experience, these differences were not significant. Instead, it appears that student perceptions of their course experience are only minimally influenced by these factors.

Introduction

The ways in which we deliver instruction in the engineering classroom has shifted drastically as instructors have had to adapt to available resources and student and institutional expectations (Bishop & Verleger, 2013). These changes can take many forms, such as online or in-person delivery, passive or active learning, and the breadth and variety of student learning activities. Instructors have investigated many of the available approaches and combined them in multiple ways (Badir et al., 2021; Cavalli et al., 2014; Davishahl et al., 2018; Hu et al., 2019; Kerr, 2015; White, 2020). While the approaches to education may vary widely, students are generally flexible and have responded positively to changes in format which deviate from the traditional classroom experience (Johnson, 2013; McLean & Attardi, 2018; Ogden, 2015). From the literature, there are limitations to our interpretation of these results in terms of which aspects of the student experience contribute most clearly to their perceptions of a class (Jensen et al., 2015). It is difficult to distinguish the effects of any one approach when there are such a large number of confounding variables found in an average engineering classroom. Further, it is often unclear as to the effect of the student experience on their learning outcomes or performance (Koska & Condra, 2018).

Methods

In this work, I collected data across seven academic terms and across two distinct courses. The two courses analyzed were Dynamics (ENGR 292) and Machine Component Design (ME 342) both being taught at a primarily undergraduate, polytechnic institution. Dynamics provides a traditional approach to the study of the motion of particles and rigid bodies while Machine Component Design covers stress analysis of various machine components along with multiple failure modes. Dynamics is generally completed during a student's first or second year and Machine Component Design is taken during the third or fourth year of the engineering curriculum. Over the span of time covered by this study, both courses were offered in both in-person and online formats. For a typical, in-person, offering of each course the time spent on various activities is shown in Figure 1. For online delivery, less class time is available for lab experiments or project work and in the case of ME 342, there were no lab experiments for the online offerings. Further, over time, the relative proportion of time spent on each activity has shifted so this should only be taken as an illustrative example for comparison between the two courses.

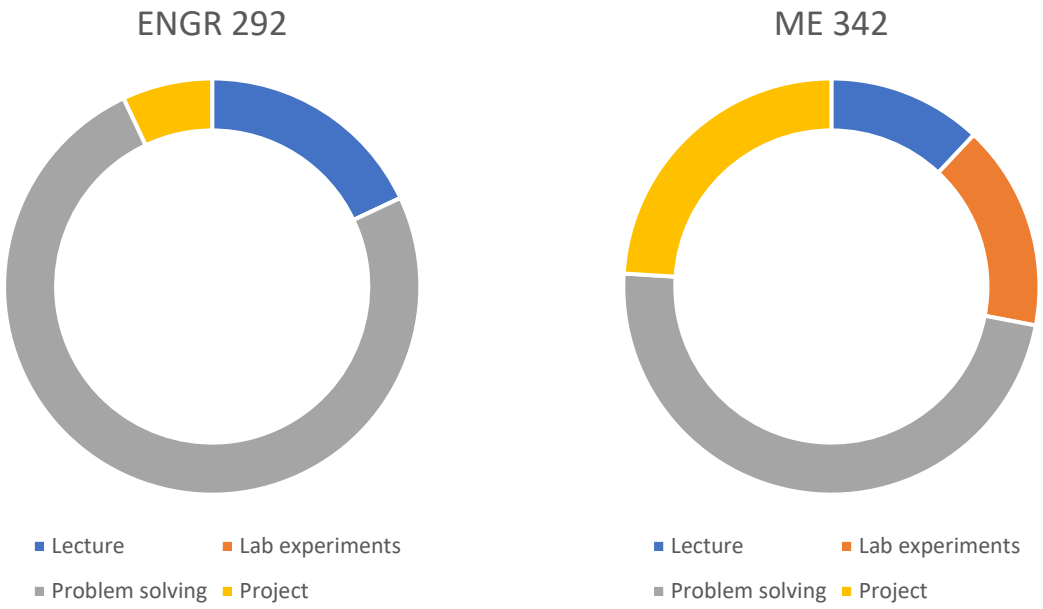

Figure 1. Chart showing the distribution of in-class time as an illustrative comparison between two courses.

The differences between these two courses and delivery modality allowed for some comparison between them based on content level (introductory for ENGR 292 and advanced for ME 342), modality (online and in-person), and lab activity (lab-intensive for ME 342 delivered in-person and non-lab-intensive for ENGR 292 and ME 342 delivered online).

At the end of each term, a survey was administered which included yes/no questions and open-ended free response questions. The total number of respondents was 331 divided across terms and courses represented here. The survey questions used here were:

- Do you feel that the format used in this course worked for you this semester? Specifically, the way that class time was structure and the types of instruction used.
- Would you have preferred a different format for the course? If yes, please explain your reasoning in the next question. If no, answer NA in the next question.
- If you answered "yes" in the previous question, please explain here. If you answered "no" in the previous question, please type NA.
- What one thing that we did this semester do you feel most helped you to be successful in this course?
- What one thing that we did this semester do you feel most hindered your ability to be successful in this course?
- In your own words, what does "polytechnic education" mean to you?
- Do you feel that this course was a good example of what you would expect from a polytechnic education?
- Using the scale below, please compare this course with other courses that you have completed at this university in terms of how hands-on the course was. (5-more hands on than other courses, 4, 3-about the same as other courses, 2, 1-less hands-on than other courses).

Results

The two courses for which survey data was collected were Dynamics (ENGR 292) (n=150) and Machine Component Design (ME 342) (n=181). ME 342 includes a scheduled laboratory time and meets for a total of five hours per week. ENGR 292 on the other hand has no scheduled laboratory time and meets for only three hours per week. A summary of the survey responses for both courses and providing a comparison between them is given in Table 1 and Figure 2. Aside from the course curriculum, the biggest difference between the two courses that is evident in the open-ended responses is that the students in each course are at different educational levels. The students in ENGR 292 have less educational experience and this was apparent in their responses in that they had fewer engineering courses to compare this one against. Much of the coursework that they are concurrently enrolled in is in mathematics and the sciences. Students in ME 342 gave responses comparing this course with other engineering courses that they have taken or were taking at the same time. Another aspect for ME 342 students is that they are typically taking several other laboratory and project-based courses concurrently, which has been expressed as being "overwhelming" due to needing to coordinate across multiple project groups at the same time and worry about time management for multiple ongoing projects.

Table 1. Survey responses comparing across courses.

	ENGR 292	**ME 342**
Format worked for them	84.0%	94.5%
Preferred a different format	27.5%	20.4%
Good example of polytechnic	88.5%	96.8%
More hands-on (score=4 or 5)	51.5%	66.9%
Average Likert score	3.5	3.9

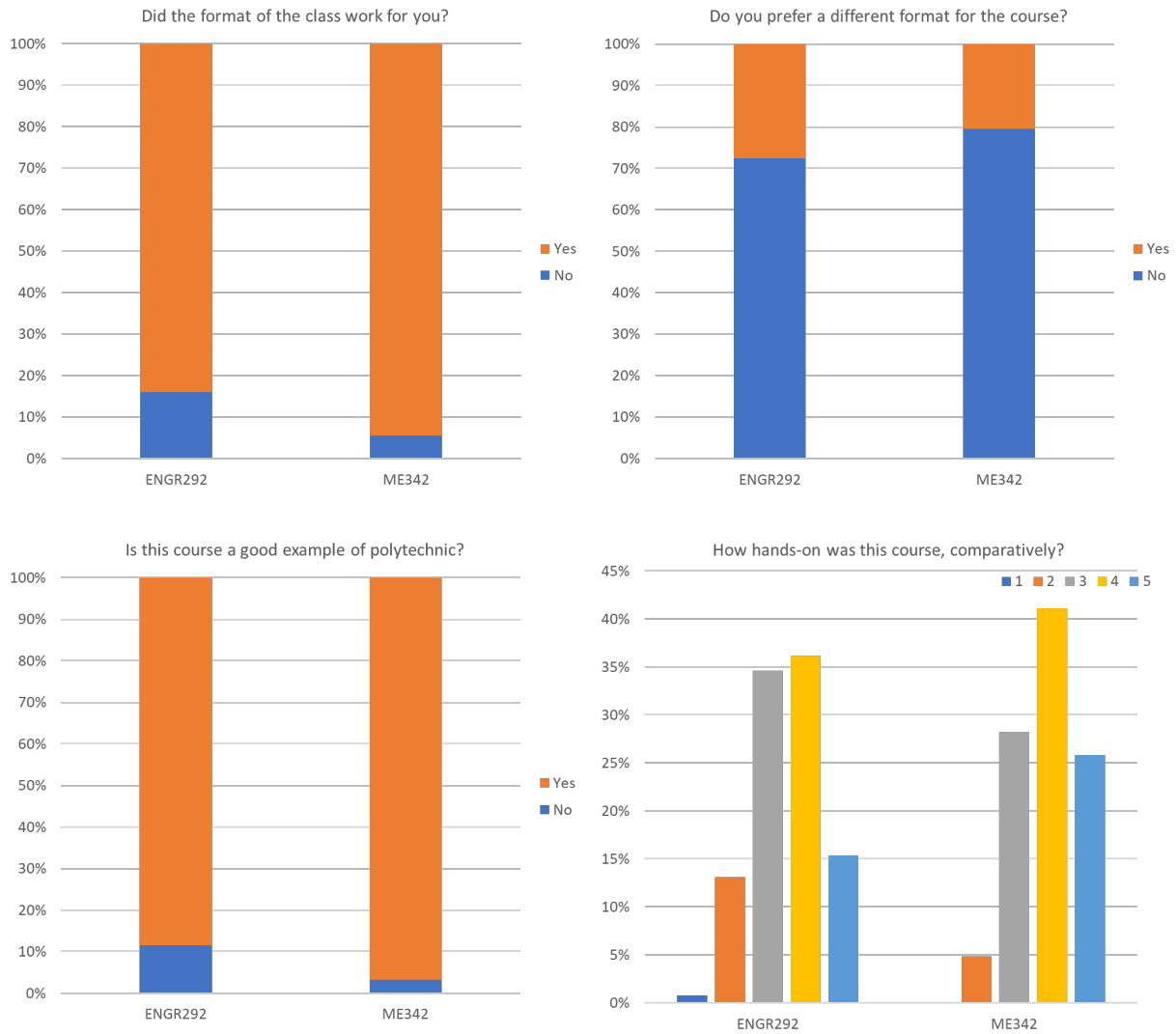

Figure 2. Results of the quantitative survey questions for comparison between courses.

Each of the courses analyzed here were delivered in both in-person (n=236) and online (n=95) formats depending on the term. A summary of the survey responses for both delivery modalities and providing a comparison between them is given in Table 2 and Figure 3. From the open-ended responses, the primarily theme that emerged was that students in the online sections had greater struggles with the group project due to challenges of scheduling meetings with group members and the difficulties of doing collaborative work in an online environment. This isn't to say that similar problems didn't occur for in-person groups. In-person students raised concerns of groupmates not contributing fairly to group work. However, these concerns were expressed in lower numbers than for online course sections.

Table 2. Survey responses comparing delivery modalities.

	In-person	Online
Format worked for them	90.3%	88.4%
Preferred a different format	19.5%	34.0%
Good example of polytechnic	94.1%	72.2%
More hands-on (score=4 or 5)	60.6%	38.9%
Average Likert score	3.7	3.1

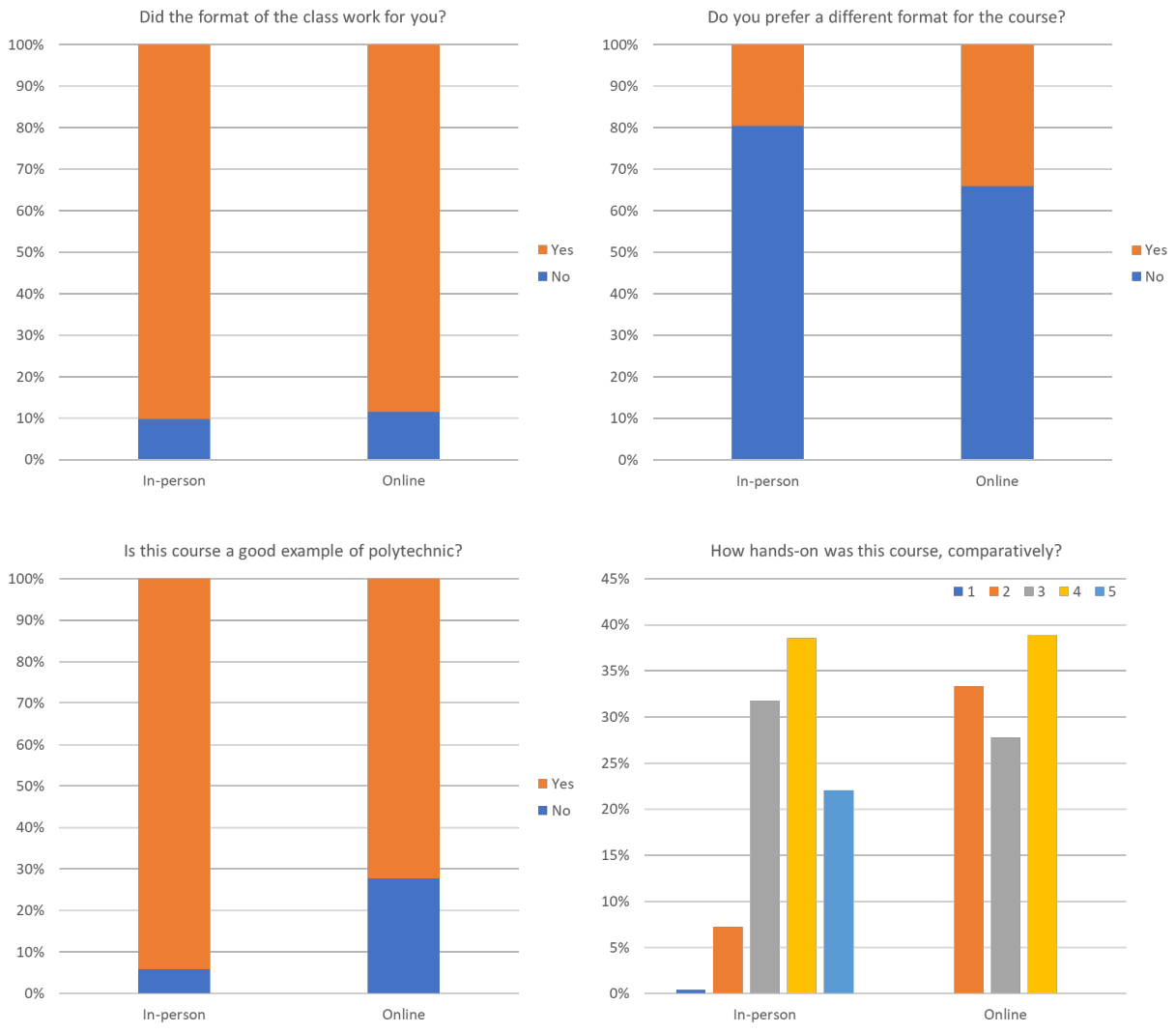

Figure 3. Results of the quantitative survey questions for comparison of delivery modalities.

Each of the courses analyzed here were delivered in both laboratory-intensive (LI) (n=124) and non-laboratory-intensive (Non-LI) (n=207) formats where ME 342 delivered in-person was considered to be an LI experience and ENGR 292 (both online and in-person) and ME 342

delivered online was considered to be a Non-LI experience. A summary of the survey responses for both delivery modalities and providing a comparison between them is given in Table 3 and Figure 4.

Table 3. Survey responses comparing laboratory experiences.

	Lab Intensive	**Non-Lab Intensive**
Format worked for them	96.8%	85.5%
Preferred a different format	12.1%	30.6%
Good example of polytechnic	96.8%	88.5%
More hands-on (score=4 or 5)	66.9%	51.5%
Average Likert score	3.9	3.5

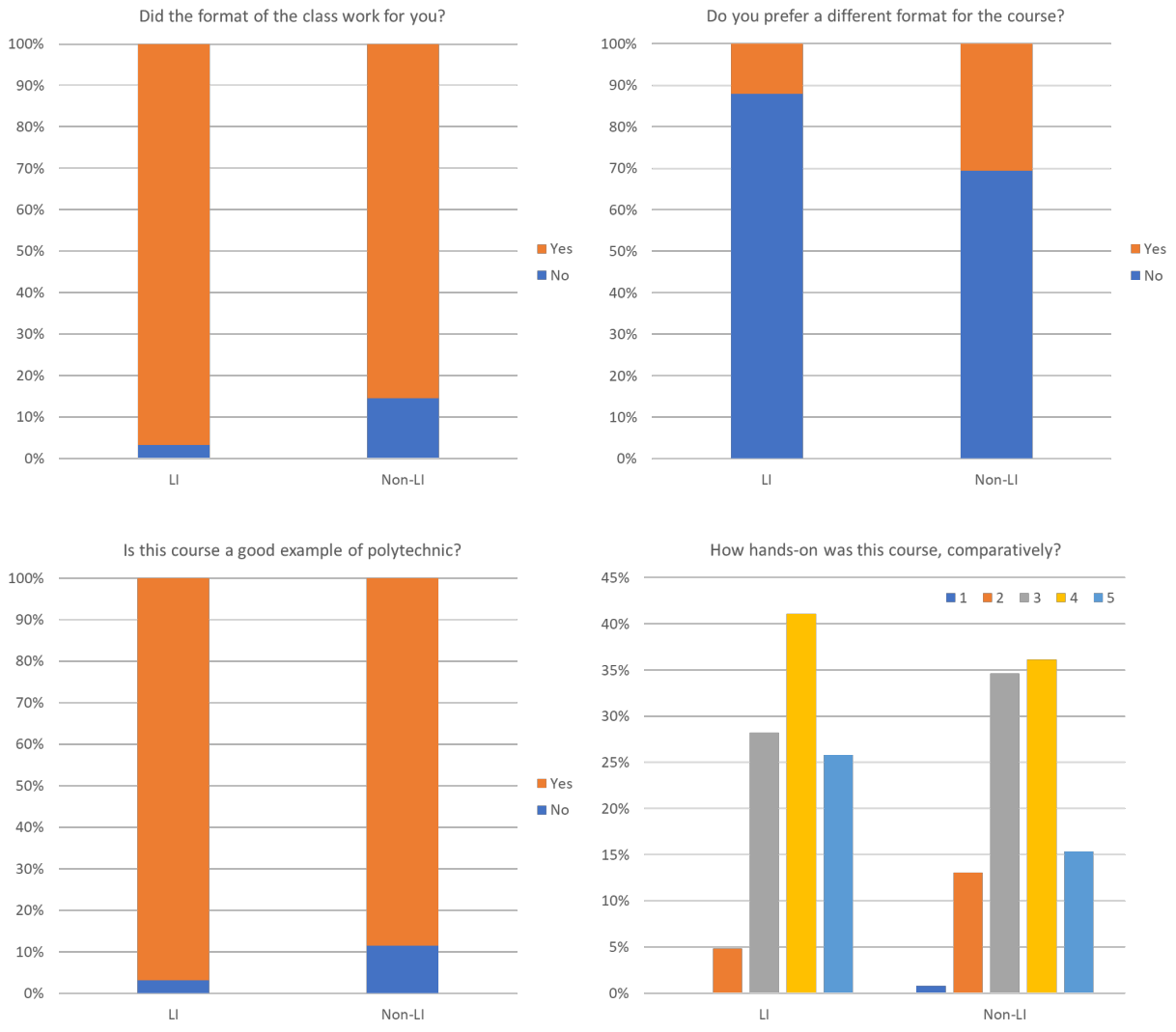

Figure 4. Results of the quantitative survey questions for comparison between laboratory experiences, laboratory-intensive (LI) and non-laboratory-intensive (Non-LI).

Conclusions

Student perceptions of the classroom experience were compared between two courses of different curriculum level, delivery modality, and laboratory setting. From the results presented in the previous section, the primary observation is that significant differences in the student perceptions of the course experience were not present regardless of curriculum, modality, or lab-activity. In all cases, most students reported that the course worked for them and that they would not have preferred an alternative experience. This result compares well with a previously reported result where it was found that student perceptions did not vary significantly across course instructors and their individual pedagogical approaches (Berg & Schmitz, 2022). The survey results suggest that students showed some preference for in-person delivery and a laboratory-intensive experience. However, this result is also partially influenced by the

difference in the curriculum and course-level between the two courses analyzed here. From the student responses to the open-ended questions, it was clear that in-person, laboratory activities was the most frequently mentioned contributor to a student's perception that a course was in-line with their understanding of a polytechnic educational experience, which is most succinctly defined as "learning something by doing it" in their words (Berg & Schmitz, 2022).

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