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Impact of Instructional Methods on Student Performance, Engagement, and Knowledge Retention: A Simultaneous Comparison of a Reflective versus Direct Approach to Fluid Mechanics

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Abstract

Frequent and formative assessments of students' knowledge retention are known to increase their overall performance and engagement in the course. These are typically administered through homework sets, quizzes, writing assignments, etc. However, there is not a consensus on which of these assessment methods (or combination of methods) is more effective at increasing student learning. It is important for students to practice the skills learned in class and to receive meaningful feedback on their efforts. How does the manner in which they practice those skills impact their grades and evaluation of the course? A variety of teaching strategies exist to facilitate student learning and have been extensively assessed and implemented, but these strategies are rarely directly compared under similar academic conditions.

In this study, a comparison of students' performance, engagement, and knowledge retention is made between four sections of Fluid Mechanics taught in the same semester by two professors (two sections each) that utilized different methods for weekly assessments and applications of the fundamental concepts. Lesson material for all sections was delivered in a similar manner – typically incorporating direct lectures, problem-solving, and contextual demonstrations/activities. All four sections were administered the same exams (four in total throughout the semester, including the final comprehensive exam). The two faculty members shared the exam grading load among the sections to ensure impartiality. Exam performances were statistically analyzed and compared between sections. Additionally, end-of-semester surveys were administered to evaluate how the students engaged with the professor, their peers, and themselves within the context of the course and the instructional methods.

For sections 1 and 2 taught by professor A, a reflective learning approach was used for weekly assessments. Reflective learning is a method that enables students to identify the gaps in their own knowledge and the areas for self-improvement. In these sections, weekly practice problems are distributed at the beginning of the week, but no formal submission was required. Instead, a weekly quiz was administered at the end of the week based on those practice problems. Additionally, the students were required to engage in an asynchronous weekly discussion forum in which they reflect upon what they learned and/or struggled to comprehend. Detailed feedback was promptly provided to students on the quizzes. An online discussion forum summary along with further clarifications was subsequently shared with students. Supplemental videos for example problems and conceptual demos were provided online for the students as additional learning tools.

For sections 3 and 4 taught by professor B, a more direct approach was used for weekly assessments. In these sections, weekly homework sets are assigned to be completed asynchronously and submitted individually. Feedback comments on these homework problems were provided individually and promptly returned. Additionally, at the beginning of each lesson, a single-question, multiple-choice quiz was administered that assessed the students' retention of one of the previous lesson's fundamental concepts. The results of those quizzes led to direct discussions and recall of the course material.

Introduction

There has been much pedagogical research into which instructional methods work best in improving students' performance, engagement, and knowledge retention in engineering mechanics courses. Recent studies have delved into the efficacy of flipping the classroom [1], incorporating more in-class activities and demos [2, 3], and switching from graded homework to homework quizzes [4]. However, there is not a consensus on which of these assessment methods (or combination of methods) is more effective at increasing student learning. Moreover, these strategies are rarely directly compared under similar academic conditions. Commonly, comparisons between teaching strategies and student outcomes are analyzed between sequential semesters, rather than simultaneous sections.

Fluid mechanics can generally be a difficult course for students which can lead to a dislike of the subject [2], therefore care is usually taken by instructors to better engage the students and make the course more palatable. Every instructor has their own approach on how to apply certain teaching strategies in their courses. Though it is less well-known how the manner in which they practice these strategies may impact student performances on common assessments. Students may have their own personal reasons for registering for one professor's section over another's, but they should still have the same opportunities for engagement and learning.

In this study, a comparison of students' performance, engagement, and knowledge retention is made between four sections of fluid mechanics taught in the same semester by two professors (two sections each) that utilized different methods for weekly assessments and applications of the fundamental concepts. All four sections were administered the same exams (three required midterms, and one optional final). The two faculty members shared the exam grading load among the sections to ensure impartiality.

The primary differences between the professor's instructional methods are in their weekly assessments of the students' knowledge. Homework is known to be important to a student's retention of material, but homework quizzes have been shown to be an equitable substitution [5]. Professor A utilized a reflective learning approach in which the students were administered weekly homework quizzes and were required to engage in an asynchronous weekly discussion forum. Professor B utilized a more direct approach in which students completed graded homework sets every week and were administered a short, multiple-choice quiz at the beginning of every class. The objective of this study is to determine whether these differences in their out of class learning strategies impact a student's performance, engagement, and knowledge retention.

These two approaches are assessed herein by comparing the student performances on the common exams. Additionally, end-of-semester surveys were administered to evaluate how the students engaged with the professor, their peers, and themselves within the context of the course and the instructional methods.

Institutional and Curriculum Information

York College of Pennsylvania (YCP) is a private institution that focuses on undergraduate education with a total enrollment of about 4200 students. The engineering program at YCP started in 1995, when the mechanical engineering (ME) program was launched; the civil engineering (CE) program began in 2016. The mechanical engineering program enrolls about 49 students per year, whereas the civil engineering program enrolls about 19 per year.

The fluid mechanics course at YCP is typically taken by students during the first semester of their third year with pre-requisite courses of engineering mechanics: statics and differential equations. The 9th edition of Fluid Mechanics by Frank M. White [8] is the textbook for the class. The lectures convene for two 75-minute periods each week. Each student also takes a co-requisite lab that meets once a week for 160 minutes.

The lecture component of the course is combined among the majors (primarily ME and CE students), but the lab components are segregated by majors. The mechanical engineering lab combines thermodynamics and fluid mechanics concepts (the ME students take a thermodynamics course in the previous semester), whereas the civil engineering lab is solely focused on fluid mechanics but emphasizes civil engineering examples and applications. This is an important note for this research because the lab component for the course is not necessarily a direct reinforcement of lecture topics since students of different majors are mixed in lectures and students of different instructors are mixed in labs.

During the fall 2021 semester when this study was done, there were four sections of fluid mechanics offered for a total of 77 students. Two sections were taught each by Professor A (41 students) and Professor B (36 students). Both instructors aligned their topic schedules so as to administer concurrent exams, but they did not share lesson curricula beyond that.

Comparison of Instructional Methods

The common instructional methods among both professors are generally the maintenance of course material and student learning outside of class. These include maintaining an up-to-date online LMS page (*learning management system*; Canvas, in our case), creating supplemental handouts as guides for note-taking, posting lecture notes on Canvas after each lecture, and holding weekly office hours. The primary differences are how each professor assesses their students' academic progress through either ungraded practice problems, weekly graded quizzes, and reflection papers (Professor A) or weekly graded problem sets and daily graded knowledge quizzes (Professor B).

Professor A methods

For the sections taught by Professor A, the instructor introduces the class learning outcomes along with the lecture outline at the beginning of the class. This is typically followed by a brief summary of the previous lecture and an example problem. The lecture material is presented by using an interactive demonstration, PowerPoint presentation, and in-class problem-solving individually and in groups. During in-class problem solving, Professor A demonstrates how to solve example problems by using engineering problem-solving strategy i.e. outlining problem definition with given and identifying what to find, listing appropriate assumptions and coming up with a solution plan/method, solving the problem, and reflecting on the results [9]. The reflection component is a vital step to improve critical thinking and problem-solving skills. The overall flow of a typical lecture is shown in Figure 1a.

Prior to class, students are provided with a lecture notes package, both physical copy and electronic versions on Canvas. The course notes include learning outcomes, information on the associated textbook chapters, conceptual knowledge, fundamental equations, derivations, practice problems, and a space to complete the solution of those problems.

In-class demonstrations include pitot-tube, hydraulic loss demo with manometers attached to a pipe, Bernoulli's principle explained by pushing air between two soda cans (higher velocity-low pressure), Venturi meter, etc. During these demonstrations, students are encouraged to predict the results. Afterward, students in groups talk about what was observed, what caused the detected behavior, misconceptions, and further applications of this phenomena in other areas.

Outside the class, the students are expected to review the course notes and practice the concepts learned by solving assigned problems from the textbook. There are office hours through Zoom and in-person to provide guidance for students on those problems. To assess students' understanding, a weekly quiz is administered and the solution to the quiz problems is posted electronically. In addition, students comment on a discussion forum regarding what they learned well from that week's class and what they have difficulty understanding. This is used as a formative assessment and diagnostic tool. The comments posted on the discussion board lead to further clarification of common misconceptions during the class period in the subsequent week. Examples of students' minute paper comments are included below.

> *"I understand the basics of Pascal's Laws that we covered (pressure acts normal to a surface; pressure always acts towards a surface; at a point in a fluid, pressure is independent of orientation so it's a scalar). At first, I was a little confused about how to implement the hydrostatic equation in liquids to calculate pressures at different depths in a fluid, but after working through the multiple example problems, the sign convention and application make a lot more sense."*

> *"This week seemed pretty straightforward to me. The problems I liked the most were the ones where the manometer stem was at an angle so you weren't directly given the change in height. Something I would like to understand better is the advantage of having different shapes for devices like manometers and barometers. I get that having it at an angle makes it more precise, but it seems like the differences would be minuscule."*

> *"The manometer example problems from class really helped show me how to set up the equations and solve for pressure. I feel confident working through these problems moving forward. I did have some trouble with the angled manometer problem. I definitely need to practice some problems like this out of the book."*

Professor B methods

For the sections taught by Professor B, the in-class instructional methods follow an ExCEEd-style engagement template [6], i.e. creating a structured and interactive presentation that helps develop an enthusiasm for the material and a rapport with the students. The overall flow of a typical lecture period is shown in Figure 1b.

Prior to the lesson, the professor has provided the students with a notes guide, both physical and digital versions. These notes guides include reference to the associated textbook chapters, a list of online links to contextual videos, specific learning objectives for the unit, practice problems and solutions, fundamental equations and symbols, and space to complete hand-written notes that follow the format of the lectures.

To help introduce the lesson topic and engage the students, a video of a real-world application of a fluid mechanics application is played on screen at the front of the room as the students enter before the class starts. These are typically YouTube videos that have been curated by the professor and generally contextualize the topic being covered that day. For example, during the unit on dimensional analysis and scale modeling, a video highlighting the wind tunnel model shop at Boeing is played [Appendix].

The first required activity for the students is an online, multiple-choice quiz based directly on a fundamental concept from the previous lesson [7]. These are open notes, but timed to be only 60 seconds in length. After the quiz, a student is called upon to provide the correct answer to the rest of the class and explain why. A brief review of the concept is provided by the instructor as necessary.

For the start of that day's material, the lesson usually begins with a broad overview of the topic and a pertinent design question. For example, during the unit on the Bernoulli equation, the question is posed as to how the fuel injector system works on a carburetor. This is usually followed by a brief demonstration of the topic, incorporating students as pandemic protocols allow. Still, with the Bernoulli unit example, well-known demos of blowing between two pieces of paper and blowing through a straw to keep a ping-pong ball aloft are used. Students are prompted to predict the results of the action and to explain what they observed afterward. The instructor then guides the students to express their observations in terms of the lesson material. For the Bernoulli demo examples, the students generally come to identify that air velocity and pressure are inversely related.

This leads into the lecture in which the instructor presents the basic concepts, definitions, and derivations of that day's topic. The lesson notes are synchronously hand-written by Professor B on a tablet that displays onto the main screen in the classroom. The student can follow along with the lecture by filling in the notes guide handouts. The students are then given example problems to complete in class with the help of their classmates while the instructor circulates and assists as necessary. The example problems are then concluded by going over them as a class with the instructor using the student responses to guide the solution. The lesson is then concluded with a review of the lesson objectives.

Outside of class, the students are expected to review the material on their own, including reading the associated textbook chapters, and completing the assigned homework problems. Scheduled office hours are available for the students to seek assistance from the instructor on these, or other, problems. To help them discover a more personal connection to the material, they are also tasked to highlight and discuss some real-world applications to any of the lesson topics that they found on their own. For this 'out-of-class engagement' assignment, they were encouraged to find something personal to them.

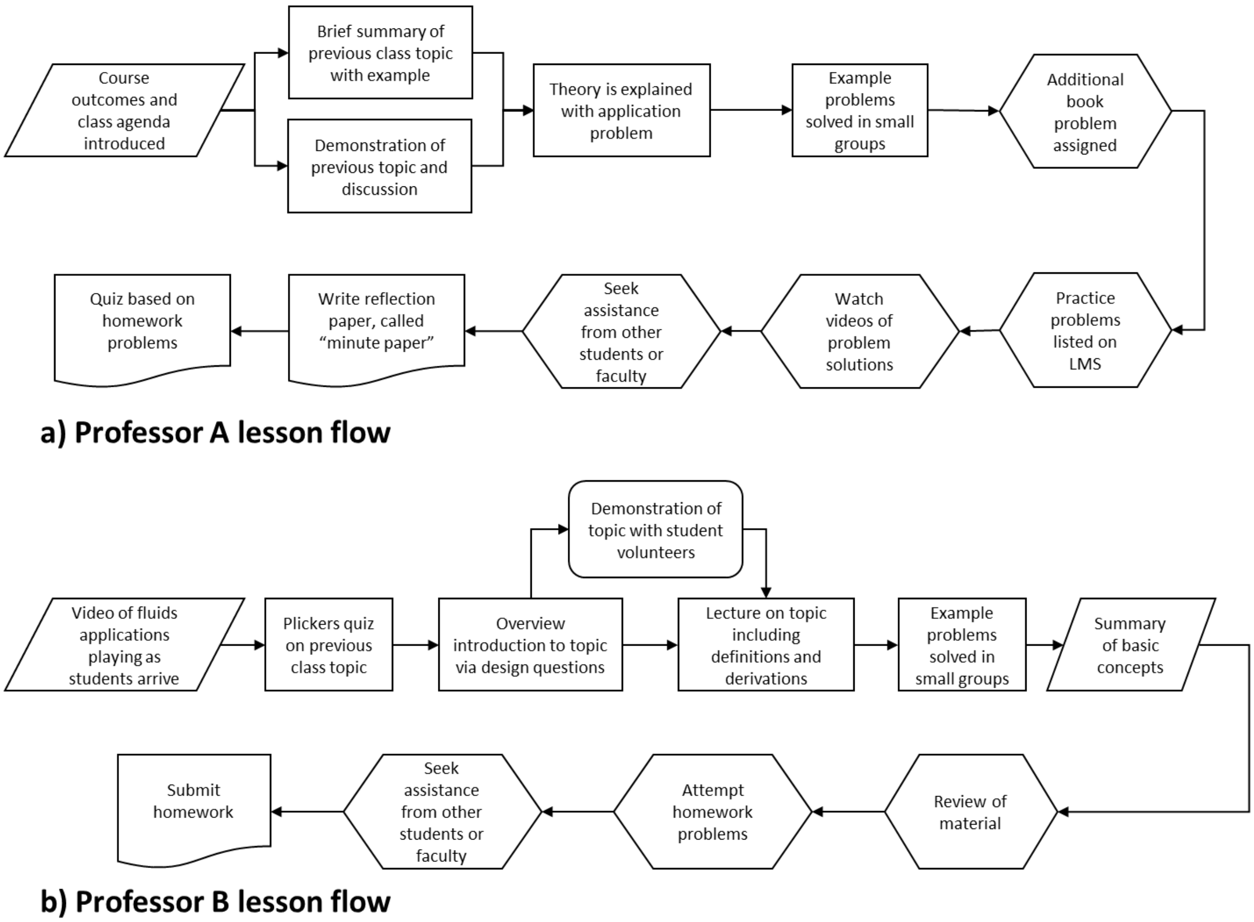

Figure 1. Typical lesson flow for each section. Trapezoids represent information delivery, rectangles represent interactive activities among course participants, hexagons represent expected student actions outside of class, and documents represent required submissions. Demos occurred during some, but not all, of the lessons.

Methods for Comparisons

Common Exams

The only component that was truly the same between all sections was the exams. There were three midterm exams and one final exam. Midterm exams were administered during one of the lecture periods (75 minutes), and the final exam was during a designated 120-minute period after the regular semester ended. Both professors conferred on creating each exam and shared the grading load to avoid any bias. Professor A would grade half of the problems for all students in all sections, and Professor B would grade the other half. Care was taken to ensure that no exam problems were unfairly tilted towards material covered in any one section. In theory, all students from any section had equal opportunity to earn a perfect score on any exam. The final exam was only mandatory for students if they averaged less than 75% on the three midterms, otherwise it is optional for the individual student. This was a common rule for all sections.

The exam problems can be generally categorized into six broad topics: fluid properties, hydrostatics, hydrodynamics (including mass, momentum, and energy), dimensional analysis and modeling, confined flow in pipes, and drag force. These are typical unit segregations for any fluid mechanics course. Exam 1 covered fluid properties and hydrostatics, exam 2 covered hydrodynamics, and exam 3 covered the remaining topics. The optional final exam was comprehensive.

Exam problems varied in style from multiple-choice (conceptual questions that require little to no calculations) to simple problems (generally require 1-2 calculations to solve) to medium problems (2+ calculations with no avoidable complications). Because of the limited time constraints, more challenging problems, i.e. ones that require a complete solution with multiple steps, were generally avoided or split into a series of simpler problems. The problems ranged in point value (5 – 30), and partial credit was awarded for incorrect answers, including the multiple-choice problems. The total possible points for each exam was 100, but the first two exams had extra credit available to the students (up to 10 points on Exam 1, and up to 5 points on Exam 2), while the third exam did not.

End-of-semester Surveys

At the end of the semester, during the last lecture period, students were asked to complete an anonymous, online survey about their experiences in the course. The survey questions were categorized into: social interaction, personal motivation, instructor interaction, and instructional methods. The first three categories were rated on a four-point scale (Strongly Agree, Agree, Slightly Disagree, and Disagree), while the last category was rated on a five-point scale (Extremely Useful, Very Useful, Moderately Useful, Slightly Useful, and Not at all Useful). The questions in the social interaction category were meant to assess how well each professor's teaching strategy encouraged interactions among the students. The personal motivation category assessed how well each student felt encouraged to learn within the confines of the course. The instructor interaction category assessed how well each instructor stimulated learning among the students. The instructional methods category asked the students to rate the usefulness of each professor's teaching tools to their learning. For this last category, there were some common tools utilized by each professor, as well as their own unique methods that were incorporated into their sections.

Results

Exam Comparisons

The only direct numerical performance comparisons that can be made between the sections are the midterm exam scores. The mean exam scores were generally within a couple of percentage points of each other (Table 1); however, statistical two-sample t-tests show no significant differences between them [$t_1(76)=-0.3$, $p_1=0.76$; $t_s(72)=-0.8$, $p_2=0.44$; $t_3(0.8)$, $p_3=0.4$]. Because the final exam was not taken by all students, it is not included in these comparisons. The range of scores on each exam are also very similar between sections. Because ABET (*Accreditation Board for Engineering and Technology, Inc.)* uses it as a demarcation, the percent of each class that scored at least 70% on each exam was also analyzed. This is the only statistic that, by the eyeball test, shows any real difference between the sections. For the first two exams, more students in Professor B's sections scored at least 70%, but this is reversed for the third exam.

Table 1. Comparison of student performances on exams

	PROFESSOR A				PROFESSOR B		
	Mean/Std dev	*Max/min*	*% > 70%*		*Mean/Std dev*	*Max/min*	*% > 70%*
EXAM 1	79.6 / 13.3	103 / 51	70.5		80.5 / 12.8	102 / 49	77.8
EXAM 2	78.5 / 10.7	97 / 57.5	73.8		80.4 / 11.6	100.5 / 50.5	83.3
EXAM 3	82.6 / 10.5	96.5 / 57	85.7		80.5 / 10.9	98 / 56	77.8

Beyond just the overall exam means, the student performances per topic were analyzed (Table 2). Each exam problem was categorized into one of the six topics. Each student's scores on those problems within each category was normalized into a percentage, and those percentages were then averaged.

Table 2. Comparison of student performances on unit topics

	PROFESSOR A			PROFESSOR B	
	Mean / Std dev	*% > 70%*		*Mean / Std dev*	*% > 70%*
FLUID PROPERTIES	75.3 / 20.1	58.1		81.9 / 18.5	72.2
HYDROSTATICS	78.2 / 14.5	72.1		76.7 / 12.5	75.0
HYDRODYNAMICS	76.9 / 10.3	73.2		79.0 / 11.8	80.6
DIMENSIONAL ANALYSIS & MODELING	86.0 / 18.7	85.4		81.2 / 20.7	72.2
CONFINED FLOW THROUGH PIPES	78.8 / 11.9	73.2		79.5 / 10.7	83.3
DRAG FORCE	88.7 / 14.2	92.7		82.5 / 14.9	83.3

The exam results highlight some minimal differences in student performances: students in Professor A's sections did a little better on drag force and modeling questions, while students in Professor B's sections did a little better on fluid properties and hydrodynamics questions. However, those differences are not statistically significant. Thus, the differences in teaching styles and assessment methods do not seem to impact a student's knowledge retention or application.

Student Surveys

The student surveys were distributed and administered online. The students were given the option to scan a QR code and complete it on their phone, or to follow a link provided on the course LMS page. The response rates were similar between the sections (Table 3), with an average completion time of 5.1 minutes.

Table 3. Comparison of students in fluid mechanics sections

	PROFESSOR A SECTIONS	PROFESSOR B SECTIONS
TOTAL # OF STUDENTS IN COURSE	41	36
TOTAL # OF RESPONSES BY MAJOR (ME/CE/OTHER)	26/6/1	7/21/0
TOTAL # OF RESPONSES BY GENDER (M/F/NB)	29/4/0	23/4/1
INCOMING OVERALL GPA	3.36	3.45
FINAL COURSE GRADE GPA	2.93	2.74

For most of the questions that were meant to assess any differences in their social interaction, personal motivation, and instructor interactions, there are no significant differences ($p>0.05$, for two-sample t-tests) between the student cohorts (Figure 3). There was only one statement that yielded significantly different mean values. For the statement, "I utilized a variety of information resources to help me prepare for learning the course material", there was significant differences between Professor A's ($M=2.60$, $SD=0.86$) and Professor B's ($M=3.14$, $SD=0.52$) classes; $t(54)=-2.98$, $p=0.004$. These results suggest that, on average, more of the students in Professor B's classes thought they used a variety of resources to help them learn the material.

Overall, these results suggest that every student experienced essentially the same learning opportunities and classroom interactions. The highest mean values of survey responses among all sections were related to their interactions with the instructors (e.g. demonstrating enthusiasm and depth of knowledge for the subject, and providing structure to the lessons). The lowest mean values were related to their own interactions (e.g. utilizing a variety of sources for learning, and having enough time to prepare and reflect on the material).

A review of the written comments from the students do not show much more insight (Table 4). Less than a quarter of the respondents provided any kind of comment, and most of those suggested that the teaching methods do not need to change at all (from both professor's sections). A couple of the comments, from both sections, did espouse the usefulness of having graded homework, but then a couple others also suggested that nothing done outside of class time should be graded. The learning resource that was requested the most in these comments were recordings of the lectures, which may be a remnant expectation from the remote learning styles during the height of the COVID19 semesters.

Table 4. Selected student comments from surveys

"More demonstrations are always cool to see"
"Homework helped me to try and make sense of what was going on in class"
"No graded homework"
"I would recommend posting Zoom recordings to Canvas if you have them"
"More homework would be useful, felt like there was a lot of downtime between classes"
"Very good teaching method, don't change it!"
"Honestly do not think anything needs to be changed"

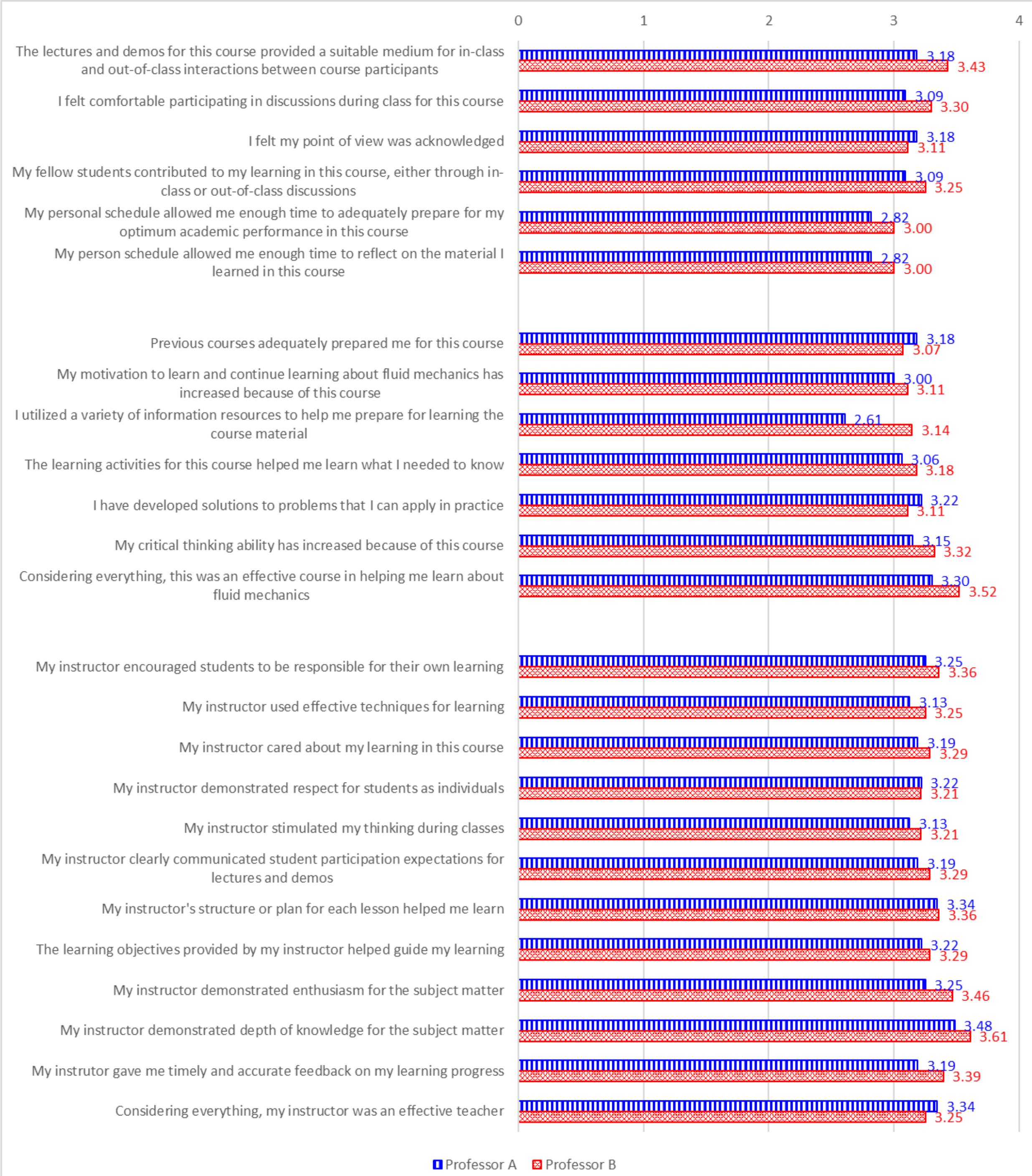

Figure 3. Means of student survey responses. 1 = Disagree, 2 = Slightly Disagree, 3 = Agree, 4 = Strongly Agree

For most of the instructional methods that were common among the sections, there are no significant differences between the student cohorts (Figure 4). The only exceptions are the usefulness of the homework and in-class instructions. The students in Professor A's sections, who had ungraded practice problems, rated its usefulness significantly less [t(54)=-3.1, p=0.002] than those students in Professor B's sections, who had weekly graded homework assignments. However, both cohorts deemed the posted homework solutions as one of the most useful tools to their learning. The other significant difference was in rating the usefulness of in-class instruction. While both means were fairly high compared to other methods, students in Professor A's sections rated it significantly less [$t(50)=-2.5$, $p=0.01$] than those in Professor B's sections. Other high mean values of survey responses among all sections included the usefulness of in-class problem-solving and notes handouts. The lowest mean values were about office hours. It is unclear (even from a review of comments) as to why office hours were rated less useful, but only a few percent of the students actually availed themselves of this option during the semester.

There are some intriguing results for those instructional methods that were unique to each professor's sections (Figure 4). For Professor A, while the homework problems themselves were deemed only moderately useful, the homework quizzes averaged about 0.5 points higher in usefulness. The Minute Papers in those sections, which were assigned in order to stimulate deeper thinking and understanding of the material, averaged less than 'moderately useful'. For Professor B, the three unique methods that were employed in those sections were also meant to stimulate a deeper connection and understanding of the lesson material. However, similarly, those methods also received the lowest rating in terms of usefulness.

A review of the student comments shows more support for the graded homework assignments, although there were no negative comments about the homework quizzes. This seems to show that students' perception of the usefulness of traditional homework is higher than its actual utility towards student performances.

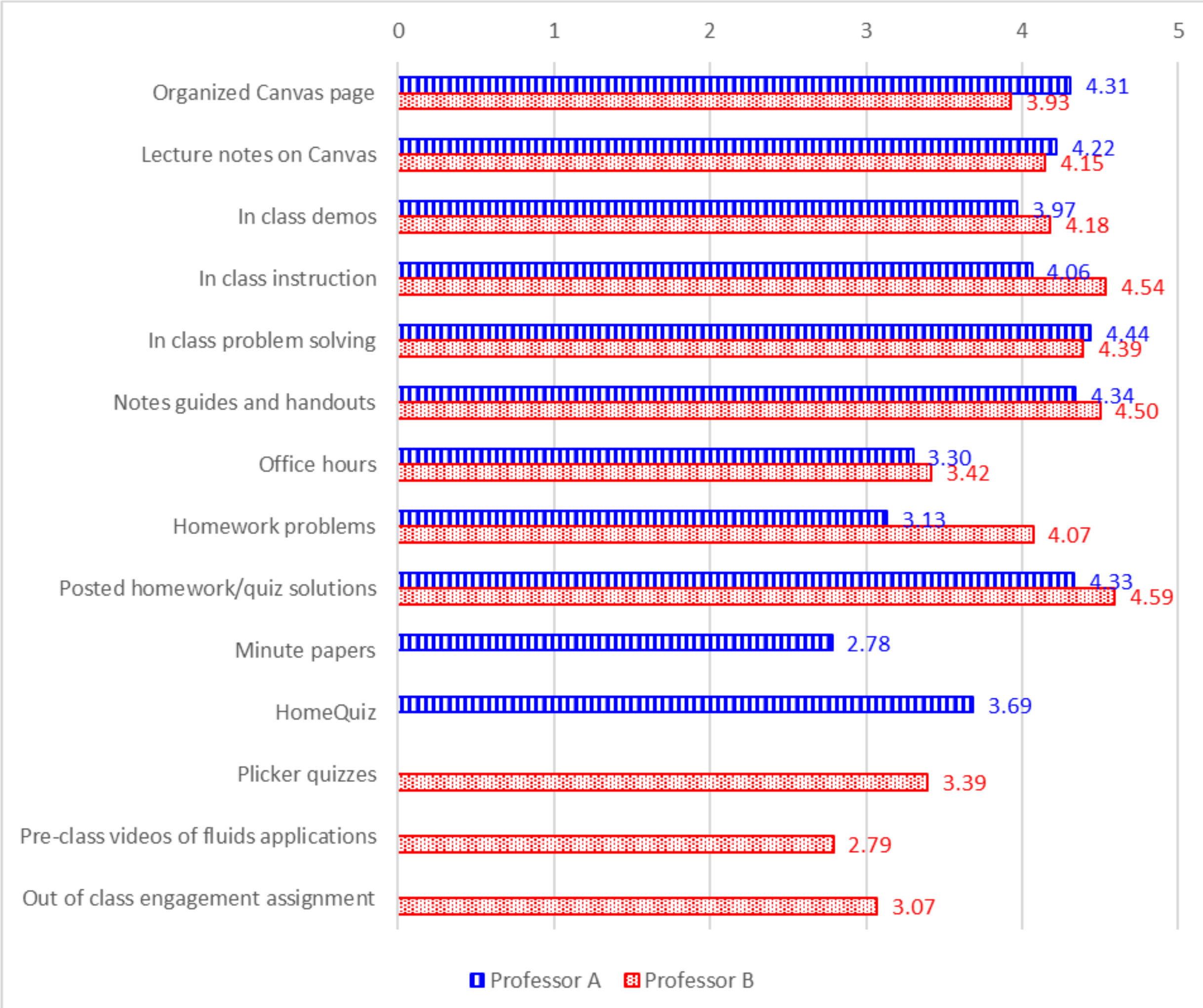

Figure 4. Means of student surveys about instructional methods. 1 = Not at all useful, 2 = Slightly useful, 3 = Moderately useful, 4 = Very useful, 5 = Extremely useful.

Discussion

Effectiveness of Out-of-class Learning Assessments

Does it improve a student's knowledge retention to require them to complete weekly, graded homework sets? This study aimed to help answer that by comparing the exam scores and survey responses between multiple sections in which some had a direct approach to learning assessment (via graded problem sets and knowledge quizzes) and some had a reflective approach (via homework quizzes and reflection papers). Based on the results of this study, there are no significant differences in student exam performances between the two cohorts. What is interesting, however, is that there seems to be a perceived usefulness from the students on the graded homework sets. Students who were required to complete and submit homework problem sets perceived them as more useful to their learning as compared to the students who had recommended problems.

Homework grading can consume a large part of an instructor's time, but many of us consider it worthwhile because our assessment should be helping our students' performances. These results could suggest that redirecting some of our instructional energy may not interfere with our students' learning.

Effectiveness of Instructional Methods

Most of the highest rated instructional methods in the student survey were common between the professors, and probably fairly common among all faculty at any institution. The unique instructional methods between the professors, which were designed to increase critical thinking skills and deemphasize rote memorization of solutions, received the lowest scores among the students. Does this mean they are not useful for student learning?

For Professor A's sections, student survey results show that minute papers were the least useful instructional tool. The minute papers were assigned and graded weekly. Some students considered the reflection process as an additional task they needed to complete outside the class. Although it is an additional task for students, it helps them to reflect on their knowledge of the material and gives them further opportunity to pose questions on the subject matter. As an instructional tool, it was helpful for the instructor to identify problem areas and misconceptions. In the future, Professor A is planning to implement minute papers as an in-class activity. At the end of the weekly class period, students will be given a couple of minutes to write down their comments on a paper instead of reporting them on the Canvas discussion board.

For Professor B's sections, the plicker quizzes were rated less useful than other in-class methods. However, from an instructor's point of view, they were very useful because they highlighted gaps in the students' learning. For subjects in which the students scored relatively poorly (e.g. buoyant force, steady flow, and Moody diagram), the quizzes provided a discussion starter to fill in those knowledge gaps. The out-of-class engagement assignment was likely rated low because of the flexible deadline. It was assigned on the first day, but not due until the last day, and most students waited until the last day to submit it. However, at least one student noted in their comments that they appreciated this assignment and how it got them to apply in-class knowledge to the real world. The pre-class contextual videos [Appendix] were rated the least useful. This could be because most students did not come early enough to watch them, even though they were usually referenced during the lectures. To strengthen the connection between the videos and student learning, they could be shown during class or even configured into a reflection assignment.

Challenges of instructional methods during a pandemic

Because of COVID-19 concerns and protocols, many of the hands-on demonstrations and interactive student activities were greatly reduced or adjusted. How does this affect student performances? The full answer to this question is beyond the scope of this study. Several student comments on the survey mentioned their desire for more demos, and the ones that were done in class were not rated as useful as some other instructional methods. Empirically, the professors observed that the students seemed less concerned about virus transmission as they often worked closely with each other and usually without proper masks when they collaborated on in-class activities. The professors were more cautious and therefore did not mandate any activity that required close contact between the students.

The empirical conclusion is that the students are hungry for more interactive demonstrations and in-class activities, so it is up to the instructors to find a way to implement more pandemic-safe options.

Implementation for future courses

In engineering programs, there is sometimes a push to completely homogenize courses that have multiple sections and multiple instructors. The reasons are usually to ensure the same material is covered and to reduce the habit of students picking one instructor over another because of how their class is run. For this study, the instructors chose to only make the exams identical between the sections. Otherwise, they had free reign to cover the material as best suited them. Observationally, it does seem that students preferentially chose one instructor over the other: a majority of the ME students were in the ME instructor's sections, and a majority of the CE students were in the CE instructor's sections. The results from this study, however, show insignificant differences in the overall academic performances, engagement, and perceptions among the students. One section, or one instructor, did not inherently offer a "better" learning experience.

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Appendix

Pre-class contextual videos used by Professor B

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- https://www.youtube.com/watch?v=3-ULlIyR3is “Race to clean up Indian Ocean oil spill” (Aug 12, 2020)
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