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Indicators of Change in Mechanical Engineering Instructors' Teaching Practices Across Five Years

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Abstract

Current best practices in teaching and learning are often not implemented in engineering courses, including those of mechanical engineering. The low rate of the adoption of best practices in teaching and learning can be attributed to the variation in training among individual educators and a lack of time to learn about and implement new teaching strategies. A significant disruption to higher education in 2020 created an opportunity for instructors to change their teaching practices. The purpose of this study was to determine the ways that instructors adjusted their teaching activities during a disruption and to identify whether those adaptations resulted in long-term teaching changes. Course syllabi were analyzed with a specific focus on active learning opportunities employed within a classroom and assessment strategies. Syllabi from 93 sophomore- and junior-level courses in a mechanical engineering department at a R1 Midwest University were examined for change over the period of Spring 2019 to Spring 2023. The syllabi were deductively coded using a priori course change typology. The results showed that in-class student activities and in-class group activities increased after the disrupted semester. Assessment focused predominantly on exams across the timeframe of the study. Some changes to instructors' teaching practices were found but the changes were often not sustained past 2021. Recommendations for mechanical engineering instructors are made.

I. Introduction (Problem Statement)

The ability to change is the first step in improving engineering education and implementing new pedagogy in the classroom [1]. An ability to adapt is understood to be one of the fundamental necessities for connecting engineering education with industry [2] and creating engineers that have high analytical, synthesis, and social capabilities [3]. Despite the need for adaptability in engineering education, research has found limited adoption and use of research-based educational strategies (RBIS) at the undergraduate level [4], [5]. The COVID-19 pandemic of 2020 created one of the first scenarios in modern education that required all instructors to significantly adapt their methods of teaching to fit a changing environment. This disruption in higher education provided an opportunity to observe potential changes in engineering courses and the adoption of RBIS.

One classroom artifact that can be used to make inferences about what happens in a course is the course's syllabus. While syllabi vary greatly between instructors and universities, they generally include information about course content, structure, and evaluation methods [6]. Traditionally, syllabi have been used as contracts between a student and an instructor. They have also served the purpose of keeping a record of course activities and providing resources to support student learning [7]. Past research has shown that syllabi, when properly analyzed, can be used to draw conclusions about the contents of a course and an instructor's teaching methods [8]. The method of analysis used in this project implements a Course Change Typology that has been developed as a part of a larger study and re-evaluated using feedback from two previous conference workshops [9], [10]. In one study, the Course Change Typology was previously used to draw conclusions about ABET learning outcomes in engineering courses through course syllabi [11]. The purpose of the current study was to use syllabi to track changes in engineering courses across five semesters that included a disruption to higher education. More specifically, the Course Change Typology was used to track changes in the core second- and third-year courses of a single engineering department, including changes in emphasis on the ABET Student Outcomes 1-7, types of course activities, and forms of assessment.

II. Background

Best practices concerning ABET student outcomes, types of course activities, and forms of assessment are described below. The ideas presented set the stage for expectations for change.

A. ABET

The lack of adaptation in engineering education has occurred despite calls for change from the Accreditation Board for Engineering Technology (ABET), which focuses on ensuring engineering curriculum meets the needs of the modern engineering industry [12]. ABET emphasizes the importance of developing technical and professional skills to better prepare graduates for the current expectations of employers [13]. A variety of competencies are needed to create holistic engineers, and ABET articulates the competencies that graduates should develop through their degree programs in Student Outcomes 1-7 [14].

B. Teaching variety and active learning

The development of technical and professional skills expected by employers requires a curriculum to be implemented with a variety of teaching practices and strategies. A variety of teaching practices and strategies can be identified by observing the qualitative differences between assignments, forms of assessment, and activities used within a course. Having different approaches to teaching is proven to enhance student understanding and account for the diversity of students' learning capabilities in the modern classroom [15], [16]. Variety is particularly impactful when it involves active learning strategies, meaning that students are expected to be more than passive participants and do more than just listen to course content, they need to engage with the content [17]. As a result of Bonwell and Eison's synthesis of active learning implementation and research, they determined that one of the most impactful factors to educational reform is faculty members' willingness to incorporate more active learning opportunities into their course delivery [18].

C. Forms of assessment

ABET criteria establishes that effective assessment within a classroom should be both qualitative and quantitative, as well as both direct and indirect [14]. This directive implies that a variety of methods should be used to evaluate student progress. In past decades, classes have traditionally maintained a lecture format, which incorporates little variety in assessment and focuses more on testing theory than practically applying technical and professional skills [19]. While summative assessment is useful in determining if overall learning objectives are being met, formative assessment provides more immediate feedback to students and instructors alike, which may help improve the classroom environment both in terms of learning and teaching. Formative assessment has also been found to have positive impacts on student morale and improve attainment of course objectives [20].

III. Research Purpose & Questions

The purpose of this paper was to use the Course Change Typology to detect changes in course activities from course syllabi over time. The research questions were:

1. What changes in ABET outcomes are detected by the Course Change Typology within mid-level mechanical engineering courses from 2019 to 2023?
2. How do course activities, as they are presented in syllabi, change from 2019 to 2023?
3. What changes in the grade weight distribution of course assignments are detected by the Course Change Typology?

IV. Methods

A. Setting and Participants

This study took place in a mechanical engineering department at a Midwestern R1 University. Table 1 outlines the number of course syllabi and number of instructors associated with the collection of courses each semester, from Spring 2019 to Spring 2023. A total of 93 syllabi were analyzed, from 39 unique instructors.

Table 1. Number of syllabi analyzed per semester

Semester	Syllabus Count	# of Instructors
Spring 2019	16	14
Spring 2020 (Regular)	15	14
Spring 2020 (COVID)	14	13
Spring 2021	17	17
Spring 2022	15	14
Spring 2023	16	15

B. Data Collection

Syllabi were collected directly from the department with the researchers reaching out to individual instructors for any missing syllabi not provided by the department. A majority of the syllabi had been collected by the department for the ABET accreditation process. For Spring 2020, each course was required to provide two syllabi – one from the beginning of the semester, and a revised version for when classes were mandated to became virtual due to the COVID-19 pandemic. This paper focused on syllabi from sophomore and junior engineering core courses for mechanical engineering during the spring semesters from 2019 to 2023. Courses from these academic levels were chosen due to the notable attrition rates recorded during the sophomore and junior years in previous research [21], [22]. There is also a lack of research on course content and instructional changes in mid-level engineering courses.

C. Data Analysis

The syllabi were analyzed through deductive coding using the Course Change Typology established in previous research [11]. The Course Change Typology consists of 59 different codes split into four categories: “general”, “what”, “how”, and “environment” codes. “General” codes were used to record basic information about each course, such as instructor and course IDs. “What” codes were used to identify the degree to which each ABET student outcome [14] was addressed in the course as evidenced in the syllabi. “How” codes focused on the activities and forms of assessment that were discussed in each syllabus. “Environment” codes identified the resources used or provided by the instructor that could have a potential impact on student learning. The analysis presented here focused on 23 codes which primarily fell into the “what” and “how” categories. The ABET student outcomes and levels of the “what” codes examined in this study are outlined in Tables 2 and 3, respectively.

Table 2. “What” code definitions

<table>
<tr><th>Dimension</th><th>Outcome</th><th>Definition [14]</th><th>Level</th></tr>
<tr><td rowspan="3">Significant Learning - Technical</td><td>ABET1</td><td>Identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics</td><td rowspan="7">0-4
(Table 3)</td></tr>
<tr><td>ABET2</td><td>Apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors</td></tr>
<tr><td>ABET6</td><td>Develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgement to draw conclusions</td></tr>
<tr><td rowspan="4">Significant Learning - Professional</td><td>ABET3</td><td>Communicate effectively with a range of audiences</td></tr>
<tr><td>ABET4</td><td>Recognize ethical and professional responsibilities in engineering situations and make informed judgements, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts</td></tr>
<tr><td>ABET5</td><td>Function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives</td></tr>
<tr><td>ABET7</td><td>Acquire and apply new knowledge as needed, using appropriate learning strategies</td></tr>
</table>

Table 3. “What” code levels

Levels	Definition
No Evidence (0)	Student outcome is omitted from course
Declared But No Evidence (1)	Student outcome is stated as being met, but there is no evidence in course content
Low (2)	5-45% of class periods or course grade is dependent on ABET student outcome
Medium (3)	45-75% of class periods or course grade is dependent on ABET student outcome
High (4)	75-100% of class periods or course grade is dependent on ABET student outcome

An additional code in in the “what” category, labeled Integration, was used to identify how student outcomes were developed alongside each other in course activities. For this code, a level of “0” indicated no evidence of integration, a “1” indicated the presence of one project or activity that incorporated two ABET skills, and a “2” indicated at least one activity that combined three or more ABET outcomes. The “how” codes that focus on evidence of active learning strategies in a course are defined in Table 4. The “how” codes that focus on assessment and grading within a course are outlined in Table 5.

Table 4. “How” code definitions focused on active learning

Code	Definition	Level
OutClass_GrpAssign	Short duration assignments that involve group work	0: Not present 1: Present
InClass_GrpAct	Activities conducted in class that involve group work (e.g., in-class problem solving, NOT teamwork (longer duration))	0: Not present 1: Present
InClass_StuActivity	Non-tech based student activities (e.g., minute papers, muddiest points, class reflection, self-grading, etc)	Count types
TeamProject	Long duration assignments with ongoing activity among team members	0: Not present 1: Present
ActVariety	(e.g., projects, papers, homework, discussion board) NOT quizzes, exam, participation/attendance	Count types

Table 5. "How" code definitions focused on assessment

Code	Definition	Level
EXAMCount	Number of exams administered	Count
QUIZCount	Number of quizzes administered	Count
EXAMper	Percent of course grade for exams	Percent
QUIZper	Percent of course grade for quizzes	Percent
HWper	Percent of course grade for homework	Percent
OTHper	Percent of course grade for other activities	Percent
TEAMPer	Percent of course grade for team participation	Percent
PAPper	Percent of course grade for papers	Percent
PRESper	Percent of course grade for presentations	Percent
LABper	Percent of course grade for lab	Percent
PRJper	Percent of course grade for projects	Percent
PARTPer	Percent of course grade for participation	Percent

Inter-rater reliability (IRR) was conducted via a simple percent agreement. Over the course of two years, four researchers conducted IRR in groups of two by individually coding 5 to 10 syllabi at a time and comparing the applied codes for reliability. When comparing, simple percent agreement was used to calculate reliability and coders would take note of differences in each other's codes and come to an agreement about how to apply or how to adjust individual codes. Definitions of each code were updated based on these discussions. This process was repeated for every set of codes (i.e., ABET, activity, assessment) until all codes reached a reliability of 80% or higher.

Following the IRR process, multiple coders each worked on coding a subset of the syllabi. Data analysis consisted of calculating averages of ABET levels and graded component percentages for each semester. Percentages were then plotted to enable visual inspection of trends across semesters. The codes which indicated the presence of a variety of activities in a course were analyzed by finding the percentage of courses in each semester that reached a minimum value for each of these codes. These percentages were then plotted alongside one another to enable comparison across semesters.

V. Results

Analysis indicated that the variety of some teaching practices in the classroom showed changes across the five observed semesters, while others showed little to no change. ABET competencies ("what" codes) are first described to provide some context about the course syllabi, these results are provided in Table 6. The "how" results that are focused on activity variety are shown in Figures 1-2. Lastly, the "how" results that focused on assessment are shown in Table 7 and Figure 3.

A. ABET Outcomes & Integration

To provide context about the focus of the second- and third-year courses, the ABET outcomes were analyzed. Table 6 features the average value of each relevant ABET outcome code by semester. Recall that a value of "0" means an ABET student outcome was not mentioned at all in a syllabus, a "1" indicates that an outcome was mentioned, but no evidence was provided of its use, and values "2," "3," and "4" indicated that an outcome was present at a low, medium, or high level, respectively, within a course. As indicated in Table 6, ABET 1 (problem solving) was the most common outcome across all semesters, with a maximum average value of 3.94 (out of 4) in 2019 and a minimum of 3.76 in 2023. ABET outcomes 2 (design), 3 (communication), 5 (teaming), and 6 (experimentation) consistently remained below a level of 1 across all semesters, meaning that most syllabi did not provide evidence that these outcomes were addressed. ABET 4 (ethics) and ABET 7 (learning strategies) consistently had average levels of less than 0.1, meaning they were almost never mentioned in syllabi from any semester.

Table 6. Average ABET levels (Spring 2019 – Spring 2023)

Semester	**ABET1**	**ABET2**	**ABET3**	**ABET4**	**ABET5**	**ABET6**	**ABET7**
Spring 2019	3.94	0.44	0.13	0.00	0.13	0.38	0.00
Spring 2020 (Regular)	3.93	0.40	0.33	0.00	0.33	0.33	0.00
Spring 2020 (COVID)	3.93	0.71	0.14	0.00	0.29	0.29	0.00
Spring 2021	3.82	0.59	0.24	0.06	0.41	0.35	0.00
Spring 2022	3.88	0.69	0.12	0.06	0.56	0.50	0.06
Spring 2023	3.76	0.35	0.12	0.00	0.53	0.41	0.00

To determine whether multiple ABET skills were integrated within the same course activity according to each syllabus, the Integration code was utilized. ABET skills integration increased from being present in at least one project (coded as a "1" or "2") in 6% of courses during Spring 2019 to being present in 50% of courses in the COVID semester (Spring 2020). Subsequently, integration generally decreased until reaching a presence of 29% in Spring 2023 courses.

B. "How" Codes: Active Learning

The "how" codes focused on identifying opportunities for active learning and indications of variety among course activities within the syllabi. The first portion of these results focuses on short-term activities mentioned in syllabi that go beyond traditional homework assignments. The second section describes results concerning the identification of longer-term projects and broader indicators of variety within a course.

Short-Term Activities. The group assignment (i.e., OutClass_GrpAssign, InClass_GrpAct**)** and in-class activity (i.e., InClass_StuActivity) code trends are recorded in Figure 1. These codes were used to identify the presence of active learning via group assignments completed in the classroom, short-term group assignments completed outside of the classroom, and individual activities completed during class time. Evidence of group assignments outside of the classroom was not present in classes until mid-Spring 2020, during which time approximately 7% of courses used this type of assignment. Following mid-Spring 2020, the percentage gradually increased, reaching a maximum of 13% in 2022.

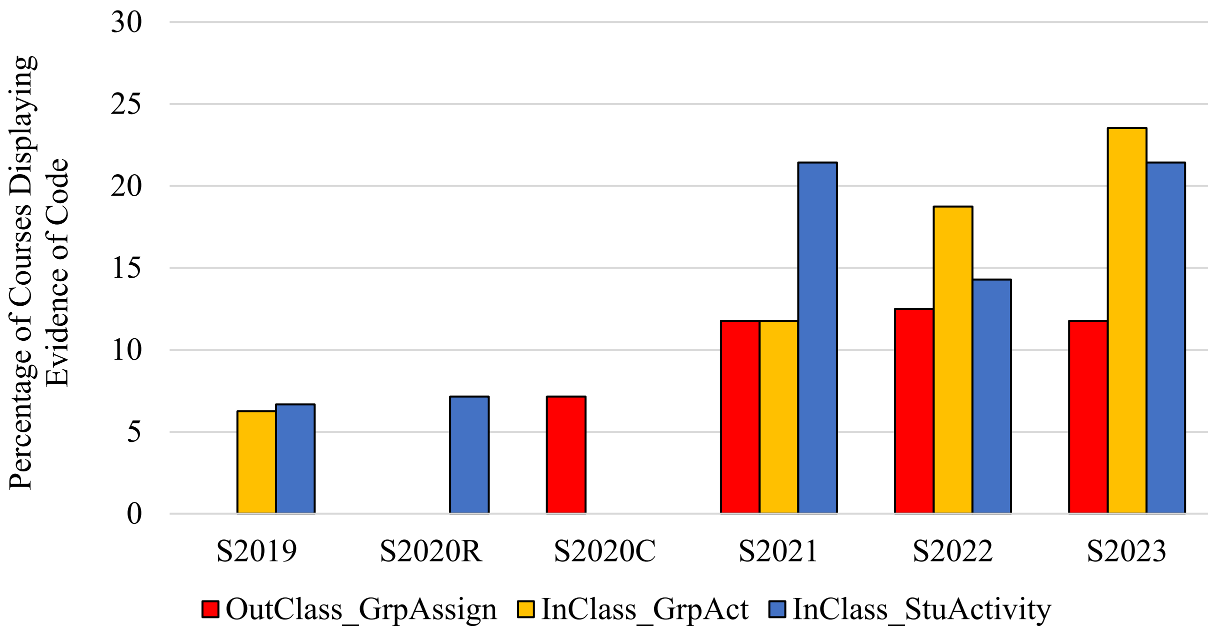

Figure 1. Percentages of courses with evidence of active learning

Group assignments inside of the classroom, on the other hand, were present in about 6% of courses during 2019, dropping to 0% in both early- and mid-spring 2020 syllabi, but increasing significantly over the following semesters, reaching a peak of 24% in 2023. Individual in-class assignments were consistently present in fewer than 10% of courses prior to COVID but increased to more than 20% by the spring of 2021. Individual in-class assignments fluctuated in 2022 and 2023, but did not fall below 10% again.

Longer-Term Projects & Other Variety Indicators. The percentages of courses displaying evidence of team projects and more than three types of activities to promote student learning are displayed in Figure 2. These percentages were established using the TeamProject and ActVariety codes. While short-term group assignments reached a minimum presence in the 2020 syllabi (0%)(Figure 1), long-term team projects were most present in the 2020 pre-COVID spring semester, with 20% of courses including at least one team project in their syllabi (Figure 2). This percentage then decreased from 2020 to 2021 (20% to 12%, respectively) and began increasing again from 2021 to 2023 (12% to 18%, respectively).

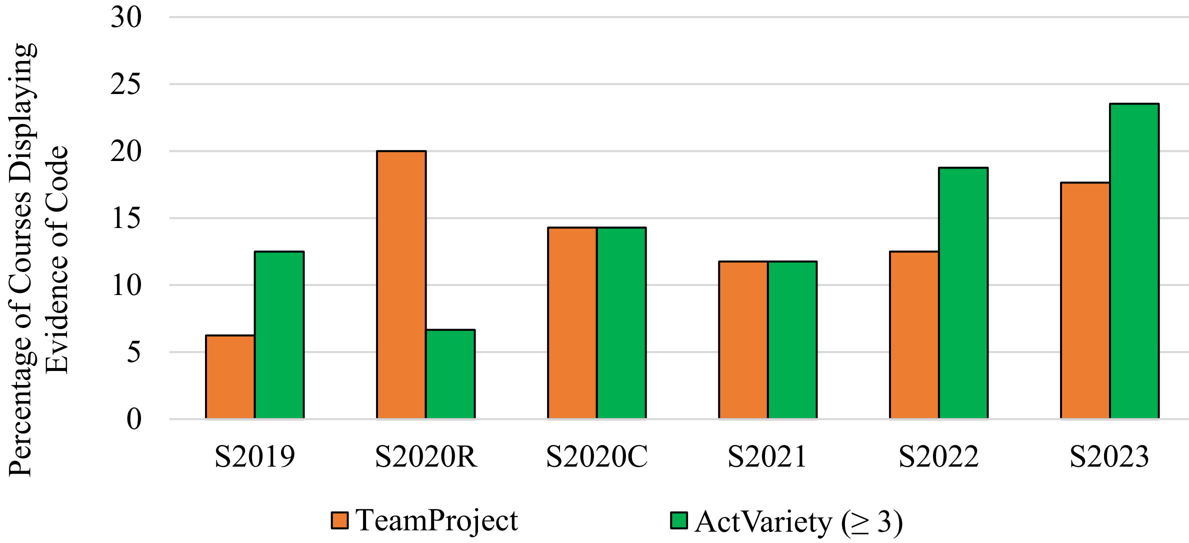

Figure 2. Percentage of courses with Team projects and Activity Variety

The presence of at least three different activities to support learning within a course, as recorded using the ActVariety code, experienced a similar fluctuation across the 2019-2021 semesters with a minimum presence of 7% in the Spring 2020 pre-COVID syllabi (Figure 2). Starting in 2021, the percentage of courses indicating three or more different learning activities began to gradually increase from 12% to a maximum of 24% in Spring 2023.

C. "How" Codes: Assessment

The following "how" codes focused on how course grades were assessed according to the syllabi. These codes were divided into categories with the goal of identifying what forms of assessment were receiving the most grade weight within a course.

Exams and Quizzes. The average number of exams and quizzes per course in each semester is shown in Table 7. These results were obtained through the use and analysis of the EXAMCount and QUIZCount codes. Average quiz counts slightly fluctuated over time, reaching a minimum average of three quizzes per course in the COVID semester (Spring 2020). Aside from that year, most other semesters had an average of 4 quizzes per course, aside from Spring 2019, which contained the highest average count of 5 quizzes. Exams remained at a consistent average count of 3 exams per course per semester across all semesters.

Table 7. Average exam and quiz counts per course (Spring 2019- Spring 2023)

Semester	Average No. Quizzes	Average No. Exams
Spring 2019	5	3
Spring 2020 (Regular)	4	3
Spring 2020 (COVID)	3	3
Spring 2021	4	3
Spring 2022	4	3
Spring 2023	3	3

Exam, Quiz, and Homework Grade Weights. The EXAMper, QUIZper, and HWper codes were used to identify what percentages of each course's grade were attributed to exams, quizzes, and homework, respectively. Results are presented in Figure 3. The weight of exams within the final grade of a course on average decreased from 2019, where the average exam percentage was 66%, to the spring 2020 COVID semester, which had an average exam weight of 57%. Starting in Spring 2021, exam percentages began increasing again, reaching a similar average value in Spring of 2023 to that of 2019, at 65%.

The weight of quizzes in the courses, however, experienced a nearly opposite trend compared to exams. Beginning with an average weight of 12% in 2019, quiz grade weights increased slightly until reaching a peak average of 15% in the 2020 COVID semester. Subsequently, these percentages dropped off until hitting an average of 8% in 2023.

Homework grade weights experienced a similar trend to that of quizzes. A peak average weight of 16% was seen in the Spring 2020 (regular) syllabi. From that point on, the homework weight generally decreased to a minimum of 11% in 2023.

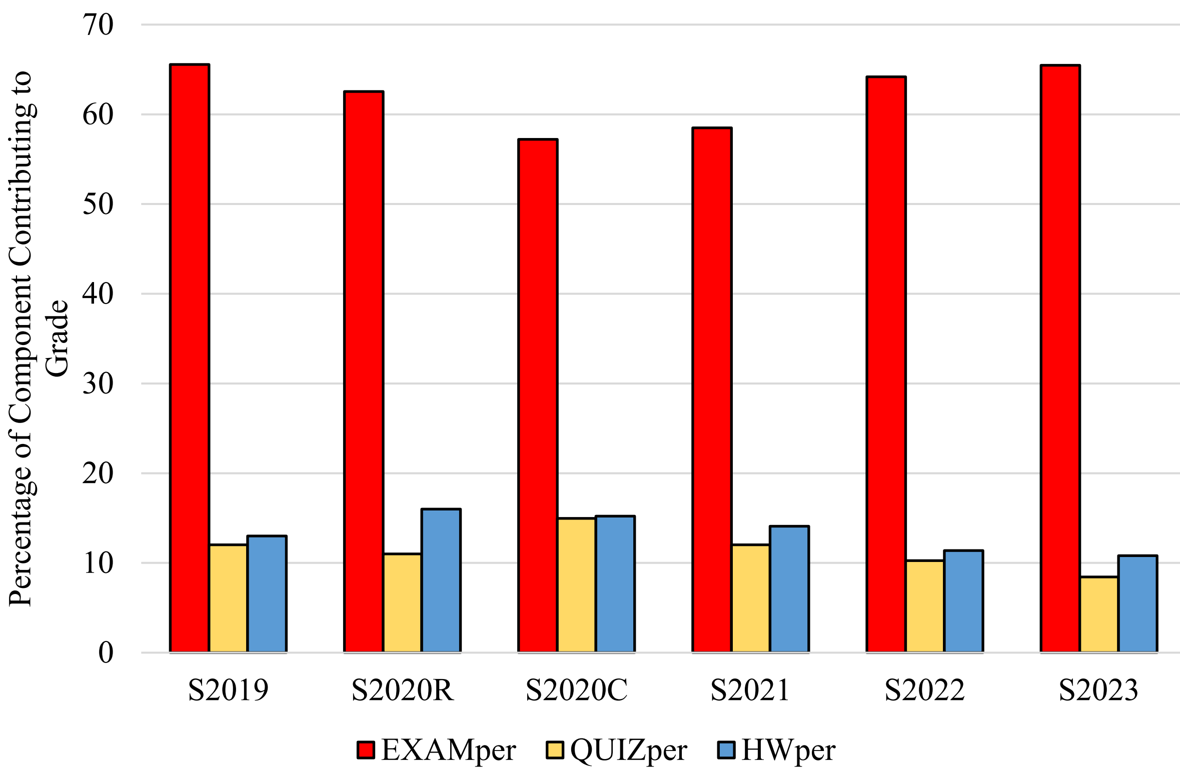

Figure 3. Average percentage of course grades attributed to exams, quizzes, and homework

Low Weight Graded Components. The weights of labs, project, and participation grades in these courses were low compared to exam, quiz, and homework weights. The average values of these weights, recorded using the LABper, PRJper, and PARTper codes, consistently remained below 8%, but averages never fell below 1%. Lab scores saw a slight decrease in course grade weight for the 2020 and 2021 semesters, with an average of approximately 4% in both pre-

COVID and post-COVID syllabi. All other semesters had an average lab grade weight between 5% and 6%. The average project grade weight experienced the most fluctuation, with a minimum of 3% in 2019 and a maximum of 7% in 2021. All other years saw project weights averaging between 5% and 6%. Participation grades consistently held an average of about 1.5% across all semesters except for 2021, which recorded an average weight of 3% for participation grades.

Very Low Weight Graded Components. The remaining graded components within these courses showed significantly less variation over time with minimal presence across all courses and semesters. The average percentage contribution to the course grade for teamwork, papers, presentations, and other assignments (recorded by the TEAMper, PAPper, PRESper and OTHper codes) remained consistently below 5% each. Team participation grades carried no weight until 2021, where the average value recorded for TEAMper was 0.4%. This average remained about the same in the 2022 and 2023 semesters. For all observed semesters, the percent of the grade attributed to papers and presentations in each course carried an average weight of 0% towards the overall course grade. The weight of "other" assignments ranged from approximately 0.1% in the 2020 COVID semester to 3% in 2023.

VI. Discussion & Recommendations

A. ABET

The lack of diversity among ABET competencies utilized in courses indicates a need for more emphasis on ABET skills 2-7. One way to for instructors to better understand how to incorporate ABET skills 2-7 in the classroom is by increasing the level of collaboration between academia and industry to incorporate the changing needs of engineering industry into curriculum [12]. Curriculum should be regularly reviewed to ensure it is meeting ABET standards across multiple courses which will enable students an opportunity to practice and refine their skills over time. From the data, it is clear that instructors need to provide students with opportunities to improve on skills that go beyond basic problem-solving. Not only is student development necessary, reflecting on how to integrate more of the ABET outcomes across the curriculum helps to fulfil the criterion of continuous improvement, which ABET establishes as a necessity for creating well-rounded engineers [14]. Instructors may be able to achieve this by considering how to combine technical skill development (ABET Student Outcomes 1, 2, and 6) with professional skill development (ABET Outcomes 3, 4, 5, and 7). One way to do this is by including a team project that integrates problem-solving with other skills such as communication, ethics, and teamwork.

B. Course activities

The increase in in-class activities & slight increase in activity variety across the timeframe of this study indicated a positive change in classrooms following COVID. These changes imply that courses improved in terms of introducing more active learning opportunities into the classroom and using a greater variety of methods for teaching course content. This expansion of methods used to engage students in learning course content has the potential to improve overall student understanding among a diverse population of students [18].

One common form of active learning that is particularly beneficial to engineering students is group learning. Group learning provides students with the chance to collaborate and share ideas with one another, which often improves content comprehension and retention [23]. For group assignments to be effective, however, they must be facilitated by an instructor, and students must be prepared to engage in meaningful collaborative efforts with teammates [24]. The increase in in-class group assignments recorded marks a positive change in the use of group learning within the classroom beyond the Spring 2020 COVID-19 semester. However, the use of team projects and out-of-class assignments did not experience as clear of an increase. It should be noted that there is occasionally difficulty in identifying specific projects pertaining to group work within a syllabus, which may be one explanation for the varying presence of these codes.

Some methods recommended by previous literature for incorporating active learning opportunities with immediate feedback into the classroom include utilizing problem-solving groups, creating time for "minute-papers" at the end of class, proposing ethical dilemmas for class discussion, incorporating low-stakes quizzes throughout lectures, and assigning open-ended projects that do not have one correct answer or path to a solution [25], [18], [16], [26]. The nature of these active learning activities relative to formative assessment are viewed as particularly beneficial to learning [27], [28]. Due to the importance of collaborative learning in developing comprehension of engineering subject matter, as well as its connections back to engineering industry, it is recommended that a specific focus is applied towards increasing opportunities for students to work with others in an environment that facilitates collaboration [29]. The National Science Foundation has supported the transition to learning environments which use a variety of assessment and teaching methods through the work of engineering-education coalitions. These coalitions have developed research-based resources to help instructors to increase variety in engineering classrooms [2].

C. Grade weight

Despite the recorded changes in the types of activities offered to students in the classroom following the disruption, a large percentage of course grades were assigned to summative assessment (exams). It is recommended that as activity variety increases, grade contributions associated with other types of course activity should increase. Exams with very heavy contributions to the overall course grade may disproportionately affect students and inaccurately represent student learning in the final course grade [30]. Distributing the course grade to lower-stake activities that promote active learning and collaboration is recommended. While formative assessment may provide opportunities to expand a grading scheme, instructors should be mindful of how much weight informal activities are assigned. The primary purpose of formative assessment is to improve the learning process by providing opportunities for near-immediate feedback in a lower-stakes setting [26]. Assigning too much grade weight to individual activities may hinder this process, especially if the grade focuses more on accuracy than completion. Rather, having numerous and frequent formative assessment opportunities allows some weight to be alleviated from exams and quizzes without over-formalizing individual activities. A more effective way for instructors to divide the grade distribution is by incorporating alternative forms of summative assessment, such as projects, papers, and portfolios. Alternative assessment forms allow students to receive feedback and make improvements over a longer period before being assigned a final grade. Furthermore, this method allows instructors to identify gaps in their teaching, and ultimately gaps in student understanding, before a course is completed [31]. These assignments also promote the use of communication and teamwork skills alongside basic problem-solving, which creates an opportunity for students to demonstrate their understanding of course-content [32].

VII. Limitations

One of the more prominent limitations of this study is the fact that individual instructors utilize different formats and guidelines when creating their syllabi, so the conclusions drawn from these artifacts are dependent on how forthcoming instructors were in outlining specific aspects of their courses. Inaccuracies may result from a lack of information provided in syllabi or from misinterpretations of information by researchers. The only teaching artifacts used within this study were syllabi. Utilizing other artifacts may provide clarification on points of uncertainty when applying the Course Change Typology. A second limitation is the sample which consisted of syllabi from a specific set of courses within one department at one university. A larger sample size would allow researchers to draw more generalizable conclusions about changes in engineering courses resulting from the pandemic.

VIII. Conclusion

This study focused on utilizing the Course Change Typology to identify changes in course focus and delivery as it related to ABET outcomes addressed, course activity, and forms of assessment within sophomore- and junior-level mechanical engineering courses. Results indicated that following COVID-19, the presence of active-learning opportunities in these classrooms notably increased. This was particularly notable in short-term group assignments both inside and outside of the classroom. Long-term team assignments, however, were not seen more often following COVID-19. The grade weight assigned to the active learning activities did not reflect the increase in their presence. It is recommended that grade weights be assigned to reflect the importance of a variety of activities in engineering courses that promote collaborative and active learning [15], [29].

Future work will use the Course Change Typology to observe other changes in engineering classrooms from 2019 to 2023 by applying and analyzing the remaining codes. Future work will also apply the typology to all course levels and to syllabi from other engineering disciplines. Future work will also incorporate other teaching artifacts including Learning Management System data and survey data from instructors.

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