A Case Study of Engineering Instructor Adaptability Through Evidence of Course Complexity Changes

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ABSTRACT

Use of a wide array of teaching practices and strategies has been shown to improve students' conceptual understanding, appeal to a diverse set of students, and preparation for engineering work. Adaptability theory provides a lens for understanding changes instructors make and can be useful for conceptualizing faculty development going forward. How an instructor's adaptability plays out in the face of new demands lies in the complexity of the courses they teach. Course complexity refers to both the extent of the array of teaching practices/strategies used in a course and the challenge to implement those practices/strategies. The purpose of this paper is to begin to examine what information is embedded in syllabi that may be used to quantify complexity via a Course Complexity Typology. This work is a case study of a single instructor-course pairing and their course syllabi from multiple semesters.

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1 INTRODUCTION

The use of a wide array of teaching practices and strategies (WATPS) has long been promoted as a means of improving student learning, including diverse learners, and preparing the next generation workforce [1-3]. Meantime, the COVID-19 pandemic shutdowns and long-term response forced instructors to adapt to the crisis as instruction moved from in-person to remote to modified-in-person delivery. This work is part of a larger project to investigate the long-term impact of events, such as the pandemic, on engineering instructors' employment of a WATPS through the development of a typology for course complexity. The purpose of this short paper is to begin to examine how syllabi may be used to reveal changes in and the extent to which a WATPS are employed by engineering instructors prior to and during the COVID-19 pandemic.

Adaptability is the theoretical framing of this study. It is novel in its focus on external motivators and therefore differs from traditional change models utilized in engineering education. Adaptability is defined as "the effectiveness of an individual's response to new demands resulting from the novel and often ill-defined problems created by uncertainty, complexity, and rapid changes in the work situation" [4, p. 3]. In this study, the external motivator for change was the COVID-19 pandemic.

Course (class) complexity accounts for the extent to which a WATPS are used in a course. The course complexity typology also considers the level of challenge for an instructor to implement each teaching practice or strategy. Practices are a focus as teaching quality is dependent on the teacher's beliefs, knowledge, and practices [5]. Practices can be directly accounted for via artifact measures such as syllabi and learning management software.

One assessment of college teaching is the Teaching Practices Inventory (TPI) [6]. The TPI provided insight into practices that might be captured from syllabi including course information (learning goals), supporting materials (e.g., notes, videos, readings), assignments (nature and frequency), other (student choice, reflection, diagnostics).

2 METHOD

Case Study Methodology

A case study approach was utilized in this research as it allowed for a deep dive into a single participant's experience [7]. The unit of analysis for the case was an instructor-class pairing, meaning one instructor and one class they taught.

Participants & Setting

The setting for this study is a College of Engineering at a research intensive university in the United States. The instructor-class case was selected based on the instructor teaching the same class over a period of time including pre-COVID, initial COVID-shutdown, and sustained COVID impact on instruction.

Data Collection & Analysis

Class syllabi were collected for all undergraduate engineering classes taught in the period of Fall 2019 (pre-COVID) through Spring 2022. Fall (Fa) typically occurs mid-

August to mid-December and Spring (Sp) occurs mid-January to mid-May. Analysis of the syllabi was conducted by two researchers. The TPI [6] inspired coding scheme consisted of five categories: (1) Class Descriptors; (2) Student Collaboration; (3) Communication of Student Performance; (4) Opportunities to Learn; and (5) Learning Supports for Students. Within each category, at least three codes were utilized to try to capture aspects of complexity change.

3 RESULTS

Course Descriptors

For the case selected, the instructor taught a lower division required engineering class each semester from Fall 2019 through Spring 2021. A total of five syllabi were collected; these included two from Spring 2021 (original and revised for the COVID shutdown). The class was a lecture/lab class. The addition of a second section (offering) in Fall 2020 expanded the enrolment and teaching assistant support for the instructor. The delivery mode for this class was in-person (Fall 2019 and Spring 2020 prior to COVID shutdown), asynchronous (Spring 2020 COVID shutdown), in-person (Fall 2020), and online synchronous (Spring 2021).

The learning objectives were reworded in Spring 2020; however, these changes did not imply a change in learning expectations. The number of Accrediation Board for Engineering and Technology (ABET) 1-7 outcomes addressed by the course dropped from four Fall 2019 (Fa19) to three Fall 2020 (Fa20) to two Spring 2021 (Sp21), retaining problem formulation (STEM content) and experimentation and losing teaming and learning strategies use. The only integration of the learning objectives through the class activities was related to the technical content.

Student Collaboration

Student Collaboration are activities that require students to work with each other including in teams and/or groups and in and out of class. Across all syllabi, there was no indication of teamwork activities and no out of class group assignments. In-class group assignments that pertained to the labs were present on the Fa19 and Spring 2020 (Sp20) syllabi but were absent as of the Spring 2020 Covid-revision (Sp20rev) syllabi and never re-appeared.

Communication of Student Performance

Communication of Student Performance includes the transparency of student expectations and grading criteria, student access to their performance in the course, and provision of feedback. Across all time periods, there was no change in the articulation of a grading scheme, how the course grade letter was assigned, or in how academic integrity was described (standard language with course specific consequences for violations). The number of grading penalties and leniencies (typical grade deductions on assignments) increased across the data collection period. In Fall 2019, there were three instances of grading penalties which increased to six on the Sp20 and Sp20rev syllabi. Grading penalties reached a total of seven on the Fa20 and Sp21 syllabi. Leniencies followed a similar pattern increasing from one on the Fa19 syllabus to two on the Sp20 and Sp20rev syllabi to four on the Fa20 and Sp21 syllabi. Prior to Fall 2020, there was no indication that feedback would be shared with students. Starting in Fall 2020 and into Spring 2021, an indicator of feedback (posting of exam averages) was present.

Opportunities to Learn

Opportunities to learn are indicated by both the frequency and variety of assignments and the contribution these opportunities made to the class grade. The frequency of assignments (weekly), variety of assignments (homework, lab work), and the graded components (homework, quizzes, lab work, class participation) remained the same across all syllabi. Homework became a larger contributor to the class grade (reflecting a reduced number of quizzes) during the COVID shutdown (Sp20rev). The change in the homework and quiz contribution to the class grade remained thereafter.

Learning Supports for Students

Learning Supports for Students are focused on the ways that an instructor provided guidance to students for learning and includes items such as class schedule, available personal supports (e.g., for mental health) and learning supports (e.g., for writing), technology that supports learning, and means of communication (Table 1).

Table 1. Summary of Learning Supports for Students

Coded Dimension	**Summary of Indicators**
Class Schedule	• Topic-list (Fa19–Sp20) • Meeting time based (Fa20)
Personal Supports	• Mental Health resources added (Fa20–Sp21)
Learning Supports	None
Assignment Descriptions	Format and submission logistics
Expectations	• Note on effort (Sp20–Spr21) • Note on classroom culture (Sp21)
Justifications	Links required presentation of work to professional practice (Sp20-Sp20rev)
Office Hours	• Location change: in-person (Fa19–Sp20) to web-conferencing (Sp20rev-Sp21) • Hours increased: 5 (Fa19) to 15 (Sp21)
Student Communication	Email (all semesters); discouraging email through the learning management system (LMS) (Sp21)
Instructor Communication	• Quiz topic announcements (Sp20rev) • Delivery mode updates (Sp21)
Technology	• LMS (Fa19-Sp21) • Web-conferencing (Sp20rev–Sp21) • Clickers and Plagiarism detection added (Fa20-Sp21)

4 SUMMARY

Course descriptors overall appeared to indicate a reduction in course complexity as links to teaming (ABET 5) and learning strategy use (ABET 7) are removed from the syllabus. But in fact, their removal was a better reflection of what was actually being taught in the class. Development of students' teaming skills and learning strategies were not found within any of the syllabi. Student collaboration was reduced due to the elimination of group assignments; however, this reflects the impact of having to teach remotely.

Communication of Student Performance in terms of penalties and leniencies adds complexity to assignment grading but detracts from students' learning as it focuses students' attention less on learning and more on points. There is a tension here in the provision of leniencies which promote a feeling of fairness in the class and penalties which force compliance and assimilation that some students might not understand and promotes a feel that grading is arbitrary.

Opportunities to learn were consistent from week to week (e.g., homework, labs) but perhaps limited in variety which limits the kind of learning objectives that can be integrated.

There are several artifacts related to COVID seen within the Learning Supports for Students that may indicate an increase in course complexity. Technology use increased overall and appeared to have a ripple effect on the number of office hours which were conducted via web-conferencing starting in Fall 2020. This increase in hours allowed students more access to the instructional team. The level of transparency of course expectations and justifications were found to be unstable as they were only sometimes present. Justifications disappeared in Fall 2020 while at the same time leniencies and penalties further increased. The removal of justifications may indicate that the instructor became increasingly focused on managing student behaviours during COVID versus connecting course practices to the overall bigger picture of engineering practice.

Overall, the current work outlined was helpful in identifying indicators of a WATPS that could be gleamed from a syllabus. The challenge ahead is to connect the highly nuanced class changes that can be gleaned from a series of syllabi to the literature on effective teaching practices and strategies. Mapping these changes will lead to a robust course complexity typology.

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