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HyFlex, Hybrid, and Virtual Synchronous Teaching in the Engineering Classroom: An Autoethnographic Approach

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HyFlex, Hybrid, and Virtual Synchronous Teaching in the Engineering Classroom: An Autoethnographic Approach

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1. Introduction

COVID-19 has required engineering educators to re-think their definition of a classroom and approach to classroom and learning management. Some engineering educators have been forced to implement a different teaching format within the online environment. Yet, because COVID-19 is a recent phenomenon, there is limited literature highlighting best practices in conducting HyFlex, Virtual Synchronous, or Hybrid in the engineering classroom. The purpose of this study is to offer readers a collaborative autoethnographic approach summarizing the researchers' experience teaching engineering coursework in each of these learning environments. Autoethnography uses self-reflection and writing to understand and explore anecdotal and personal experiences which allows for a deeper connection across individual educator stories as well as contribute to a wider understanding of perspectives. Using a collaborative autoethnographic approach allows educators to discuss their experience, coming together to make sense of their situation, context, and experiences. The study concludes with highlighting best practices and lessons learned for applying each of these teaching and learning formats, providing compelling justification for continued use of all or parts of these teaching and learning formats as a good practice (regardless of a pandemic). Examples are provided for these engineering courses: Leadership Strategies for Quality and Productivity; Stochastic Systems Engineering; and Capstone Design. Leadership Strategies for Quality and Productivity course is an elective for Industrial Engineering Technology majors and has a pre-requisite of IET316 (Statistical Quality Control). Stochastic Systems Engineering is a required course for Industrial Engineering majors, which mainly covers probability and statistics. The Capstone Design course is for Electronic Engineering and Computer Science students, which is essentially similar across engineering majors including industrial engineering.

2. Background

This section provides a brief overview of the three teaching formats highlighted in this paper including HyFlex, Virtual Synchronous, and Hybrid.

HyFlex course design is described as a mixture of online and face-to-face learning components whereby students can choose to complete any part of course face-to-face, online synchronous, or online asynchronous [1]. From an instructional perspective, the course design typically is offered as a face-to-face class meeting combined with a video-conferencing system (whereby the class meeting is recorded); this provides students the option to attend in person, participate online, or

engage with the recorded content outside the class meeting [2]. This type of course design allows students the most flexibility as it relates time and learning mode, which is ideal for students who need to optimize work-life balance (e.g., work responsibilities, family obligations, etc…) within the course schedule [2] or have social interaction preferences [3]. However, challenges do exist from both the student and instructor perspectives. One study highlighted the online students' frustration due to lack of instruction interaction, inability to chat with peers to clear up questions, and difficult in paying attention online versus in-person [4]. Another study noted the high quantity of planning and preparation required of faculty teaching in a HyFlex mode in order for the learning to be effective [5]; since faculty cannot predict how many students will participate in each format for each class session, they may need to make changes on the fly to accommodate group work, for example.

Virtual Synchronous course design is characterized by a learning environment in which the instructor and students all meet online at the same time; in contrast, virtual asynchronous allows students to access content on their own time and at their own pace [6]. One of the biggest motivations for virtual learning (for both synchronous and asynchronous) is the increased accessibility to educational content whereby students can learn using a variety of devices and can learn from most anywhere [7]. Nevertheless, challenges still exist. In one study, the researchers noted that fostering a sense of community and collaboration was more difficult [for the instructor] in a virtual environment versus a face-to-face environment; as a consequence, instructors needs to be more intentional about using the technology and tools supported by the online setting to promote relationship building in a more explicit manner [8]. Moreover, another study highlighted the difficulty in communication within the virtual synchronous environment in that students needed to figure out new ways of communication and expressing their ideas primarily through typing and text (sans the integration of facial expressions which can provide greater meaning) [9]. In general, students tend to perceive virtual learning (synchronous or asynchronous, alike) as a lesser equivalent, with respect to perceived learning and satisfaction, in contrast to the face-to-face environment [10].

Hybrid course design, commonly referred to as blended course design, combines online instruction with in-person instruction ultimately reducing the amount of seat time within the classroom; the proportion of in-person in comparison to online content can vary depending upon the learning goals and resource availability [11]. Hybrid course design is offered for many instructional reasons. First, it can be used to promote a flipped classroom environment where certain content (lectures, reading, quizzes, etc…) can be completed online outside the classroom with the intention to dedicate in-person class time to conduct authentic learning and complete open-ended problems [12]. Second, the web-based portion of the coursework promotes student flexible to complete the assignments at a time ideal for them and allows students to work at their own pace [13]. Third, instructors can get to know the students better by interaction in both an online and in-person environment [11]. Fourth, for large classes, hybrid course design can assist in downsizing the quantity of students attending in-person (e.g., 20 students attending on Tuesday, 20 students attending on Thursday vs. 40 students attending on both Tuesday and Thursday) which allows instructors to get to know the students better [14]. Yet, challenges do exist. When students complete work online, there is limited interaction which may result in lower quantities of knowledge transfer in comparison to a face-to-face lecture and discussion [15]. Moreover, some

students view the online portion as a way for instructors to lessen their teaching load and spend less time giving students course related attention [16].

3. Methods

Given the research goals, a collaborative autoethnographic approach [17] was applied. Autoethnography employs self-reflection to recognize, explore, and appreciate personal experiences and anecdotal evidence to allow for a deeper understanding and connection across individual perspectives to contribute to a wider awareness and explanation of a phenomenon [18]. The data was collected from three different professors at three different universities: (1) Public R1 University (Predominately White) in the Midwest United States (HyFlex teaching format); (2) Hispanic Serving Institution in the Southwest United States – (Virtual Synchronous teaching format); and (3) a Russell Group University in the United Kingdom – (Hybrid teaching format). The data collection applied a structured approach, where each professor reflected upon and documented their experiences teaching during COVID-19 while considering: (1) Background and Context, (2) Teaching and Learning Changes Implemented, and (3) Lessons Learned.

4. Results and Discussion

4.1 Instructor 1 Reflection: HyFlex - Leadership Strategies for Quality and Productivity

Background and Context

I am an assistant professor at a research-intensive university located in the Midwest United States (about 40,000 students), where I have been employed since August 2018. During the summer of 2020, university administration worked with individual faculty to determine the optimal teaching format taking into consider the size of the class, the size of the room, and faculty health concerns (as requested). For the Fall 2020 semester, I was assigned to teach a [new to me] course titled, "Leadership Strategies for Quality and Productivity." This course is an elective for Industrial Engineering Technology majors and has a pre-requisite of IET316 (Statistical Quality Control). The course was scheduled for Mondays and Wednesdays at 8:30am. The class size was 13 students and it was determined the room could safely accommodate all students (sitting six feet apart). The class was taught via the HyFlex course design. Thus, if one day a student wakes up, is feeling health related symptoms, and doesn't want to risk infecting others, then the student simply shows up online during the posted class session or does the work on their own in an asynchronous manner. Then, once the student feels better, the student simply shows up in person (or continues in one of the other options).

Examples of Teaching and Learning Changes Implemented

- *"In-Class" Assignments and Accountability*: These types of assignments were used to promote participation and active learning during the class period. The "in-class" assignments were also intended to incentivize synchronous class participation (either through in-person or virtual). For students who attended class synchronously during the designated class period, they got to work in groups and had no problem finishing the required assignment during the class period. For those that chose not to participate during

the class, they did not receive the assistance of a group and would have to do the assignment on their own which likely took them longer than the class period to finish the assignment. To accommodate students who chose to participate asynchronously, the assignment deadline was 11:59pm.

- *"In-Class" Assignments and Google Docs*: On Mondays, the "in-class" assignments utilized Google Docs. Prior to class, I created the assignment template in Google Docs. During the class period, once I knew which students were in attendance, I would randomly place students in teams and email them the link to the Google Doc to start working. I intentionally assigned in-person students to their own groups, and online students to their own groups; this promoted fairness for the in-person students who clearly have a preference for in-person versus online. For students in the class, I walk around and see if they have questions. For students online, I pop in the breakout room to see if they have questions. For both groups of students, I go to their Google Docs to oversee their work to ensure they are on the right track. At the end of the class, I do a debrief highlighting one good example from each group.
- *Videoconference System*: During the first few weeks of the semester, I used WebEx (as it is the institution's default videoconferencing tool). However, I quickly realized the difficulty for students to complete groupwork online without disrupting each other. In week 3, I switched to Zoom as it allowed for breakout rooms. During the class period, after assigning the teams to conduct collaborative group work using the Google Docs, I would assign the online teams to breakout rooms and then pop in as needed to see if they had any questions and/or provide feedback based on the work completed in the Google Docs.

Lessons Learned

The Fall 2020 semester required thinking outside the box and trying new things. HyFlex teaching requires a lot of preparation, and even then, things don't always go as planned. Moving forward, I plan to institute a "reservation" system whereby students need to decide within two hours of class if they plan to participate in-person, online synchronous, or online asynchronous. This will allow additional time for planning group work (if allowed based on the numbers) and other assignments that are people dependent. Also, in the event the class size is less than 10, knowing what I know now, I would work with administration to request the course be completely face-to-face, completely virtually synchronous, or complete virtually asynchronous as the HyFlex model works much better with bigger class sizes.

4.2 Instructor 2 Reflection: Virtual Synchronous – Stochastic Systems Engineering

Background and Context

I am an assistant professor of engineering at a United States public university. The university is designated by the federal government as a Hispanic Serving Institution (HSI) with a population of Hispanic students exceeding 25% from about 5000 students enrolled per year. This university is a comprehensive regional university that offers a limited number of graduate programs and a broad array of baccalaureate degree programs with a strong professional focus and a firm grounding in the liberal arts and sciences. I have been employed by the university since August 2015. In the Fall 2020 semester, I taught Stochastic Systems Engineering. Before COVID-19, I taught all my

courses face-to-face in physical classrooms, and I did not have any prior online course teaching experience. I generally utilized PowerPoint-slide-based lecture presentations and physical classroom whiteboard to teach the course materials in class. School emails were heavily used to communicate with students outside of the classroom and office hours. I also implemented an open-door policy so that students could walk-in to ask questions any time they saw my office door open. Course materials were made accessible through the official course site that is being used by our university – the Blackboard.

Overview of Teaching and Learning Changes Implemented

- *Videoconference System*: I used the Zoom video communications platform that was adapted as the official virtual instructional technology tool by our university. I created one Zoom ID and access code per course valid for the entire semester for any virtual interaction pertaining to the course including the class lectures and holding office hours. Any meetings outside of the class time were run via Zoom using the same access information used for lectures to avoid confusions, as students tend to have multiple Zoom meetings a day with different meeting IDs for their other classes as well. The Zoom access information was available only to the students taking the course. For student convenience, the Zoom meeting link for each course was integrated into the Blackboard course site. The access information was also included in the course syllabus. Office hours were held remotely for this course.
- *Zoom "Whiteboard"*: When teaching in a physical classroom, I would typically use the whiteboard to write notes on during lectures; in the Zoom environment, I used a Wacom tablet and touch screen laptop with stylus pen, which was more convenient for myself and the students. I utilized the "screen sharing" feature of Zoom to present the course material lectures from my Wacom and personal computers, while students could follow along from their personal electronic devices.
- *Course Assignments – Publisher Resources:* For the homework assignments, my initial thought was to use Blackboard to post the homework assignment questions and receive submissions through the course site as well. However, I did some research for probability and statistics textbooks that have e-book versions and online homework assignments. Luckily, the WileyPLUS version of the *Applied Statistics and Probability for Engineers (7th edition)* textbook has that capability, and I decided to adapt it as the textbook for the course. The homework assignments were auto graded through the WileyPLUS. The publisher provides sufficient explanations for the homework solutions. For each homework assignment, I randomly selected problems and solved them to verify the accuracy of the solutions. I also encouraged the students to communicate to me any homework problem solutions that did not make sense to them, and I resolved the problems to make sure that they understood the solutions correctly.

Lessons Learned

Once the COVID-19 pandemic is behind us, leveraging virtual synchronous instructional technology will be vital for educational efficacy especially during school closures due to factors such as snowstorms. Moving forward, there are a number of things I will keep or do differently. First, students asked fewer questions during the synchronous lectures compared to face-to-face

lectures. When I inquired about this, a few mentioned to me that they did not want to interrupt me, while others thought it would sound rude to interrupt me to ask questions in the middle of the class lectures. In the future, I will be more explicit to allow time for students to ask questions at regular intervals throughout the class period. Second, I plan to offer virtual synchronous office hours. Prior to COVID, I used to meet students in the computer labs and assist them one-on-one. Now, using the virtual "screen sharing" capability, I can serve my students while sitting in my physical office or working from home. Third, the integration of Wiley's auto grading system improved my teaching efficiency immensely. Students would instantly receive a solution to the problem they incorrectly answered. As a result, I was able to avoid the grading redundancy for my teaching assistants. Finally, the switch to online homework assignment submissions is good for the environment and saves students printing money; however, the university has to increase its server storage capacity proportional to the storage demand. Thus, a request has been made to administration.

4.3 Instructor 3 Reflection: Hybrid – Capstone Design

Background and Context

I am a lecturer (assistant professor) within the School of Electronic Engineering and Computer Science at Queen Mary University of London. COVID-19 provided us with an opportunity to think outside the box when it came to re-designing our delivery model for the fall semester in 2020. Given the COVID-19 restrictions, course instructors could deliver their sessions online or on campus (with a restricted number of students, which was facilitated via an online booking system). For the Fall 2020 semester, I was the instructor for the Undergraduate Final Year Project (aka, Capstone Design), which included 323 students in their final year of undergraduate study. This is the most crucial element of the degree program within our discipline, as it gives students an opportunity to work on an extensive piece of work within the areas of Electronic Engineering and Computer Science. The project also allows students to demonstrate their problem-solving abilities by being able to apply a range of skills that they have acquired throughout their degree program.

Overview of Teaching and Learning Changes Implemented

- *Preparation (Outside of Class) - Interactive Videos*: As the co-ordinator for undergraduate projects, I am always looking for way to measure and improve student engagement. This is important because the project is an important element of a degree program and is also a significant piece of independent work that students undertake over two semesters. Hence, it is important to ensure that students are engaged and motivated. This became even more significant given the pandemic and the asynchronous/synchronous way of teaching that we were planning to deploy during the fall semester in 2020. In order to address this challenge, for the first step (preparation) of the blended learning approach, I developed an online e-series, which was made up of small interactive videos (5-10 minutes) that students needed to watch before the live session. These interactive videos were developed using H5P – HTML5 Package (a framework that allows users to create interactive content), which allowed me to track student engagement in terms if they had watched the video and answered the embedded interactive questions that appeared during the video. One of the reasons for using this mechanism is that it can be difficult to see if a large class (300+

students) are engaging with the content being delivered during the course. Hence asking students to watch the pre-recorded short videos before the live session provided me with an indication of the students who were not engaging. Hence, I was able to contact the supervisors of the students who were not engaging to find out the reason for low engagement, as this could be down to many factors. Hence being aware of these issues, can enable the institution to provide students the necessary support to re-engage with their studies.

- *Live Session (During Class) - Interactive Polls*: During the live session, I would elaborate on the content covered in the e-series and initiate a series of interactive polls using *Mentimeter* to interact with the large group of students. I also found it extremely useful to have a moderator who filtered the questions through to me, so that I could concentrate on delivering the live session. I would then answer the questions during the final segment of the live session. I did not make use of Microsoft teams for the live sessions, as this was a large class (300+), hence I used Blackboard Collaborate, which also had chat and breakout facilities.
- *Post (Outside of Class) – Application*: The post session activities required the students to apply the principles they learnt during the e-series and live sessions to their project deliverables, such as literature review, interim report, presentation slides and final report.

Lessons Learned

During the fall semester of 2020, I have come across a few challenges, however I have also discovered many good practices that I will adopt going forward into a post-COVID world. One of the biggest challenges I have faced is during the live sessions for the larger class, which is being able to see if students are actually engaging. As there have been many instances where I would have 250+ students present in the class, however whenever I would conduct a poll only 100+ students would respond. Now there can be many reasons for this, one being that students may have a poor internet connection, or they are possibly watching the live sessions on a small screen (e.g., smart phone) as opposed to a laptop. Nevertheless, this will always be a challenge, as if students do not turn on their cameras or respond to polls then how will you know if they are actually watching your live session? In terms of good practices, I will continue to use many of collaborative tools such as Microsoft Teams channels to facilitate group projects. In addition to this, I felt that the e-series of interactive videos was an excellent way to capture engagement stats of students engaging or struggling with the content before the live session, which was very insightful.

5. Conclusions

In conclusion, the purpose of this study was to offer readers a collaborative autoethnographic approach summarizing the researchers' experience teaching engineering coursework including industrial engineering/technology courses during the COVID-19 pandemic. Three different teaching formats were addressed: HyFlex, Virtual Synchronous, and Hybird. In addition, three different types of engineering courses were considered: Leadership Strategies for Quality and Productivity; Stochastic Systems Engineering; and Capstone Design. It is the researchers' intention that the act of sharing best practices can assist others in teaching efficiently and effectively, not only during a pandemic but also for teaching during normal circumstances. The overarching goal of this research is to "move the needle" with respect to improving persistence

and completion rates of engineering students worldwide through implementing best practices in teaching. Although our focus was on best practices within engineering, we are confident that other courses outside of engineering would also benefit from this information.

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