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The Effectiveness of Synchronous vs. Asynchronous Modes of Instruction in an Online Flipped Design Thinking Course

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The Effectiveness of Synchronous vs Asynchronous Modes of Instruction in an Online Active Design Thinking Course

Introduction

This is a complete research paper. Online courses are in demand in today's world as they broaden the reach of education including non-traditional students and students with diverse backgrounds. Higher education institutions are adapting distance education as it breaks down geographical barriers [1]. According to Strong et. al, "regardless of the advantages of online learning opportunities for students and institutions, the need to evaluate the delivery still exists" [2, p. 99]. Online teaching and learning occur in different forms around the globe. In a university setting online teaching and learning "relies predominantly, if not solely, on asynchronous text-based communication" [3], [4], [5, p. 177]. This asynchronous text-based communication has challenges associated with it including lack of interpersonal interaction with students and the need for different instructional skills [6]. According to Lowenthal et al., "live synchronous video-based communication can address many of the challenges of asynchronous text-based communication" [5, p. 178].

A review of literature suggests that both synchronous and asynchronous online learning has its own advantages and disadvantages. Synchronous online learning has advantages such as interaction, a classroom environment and better student perception of course whereas asynchronous online learning has advantages such as self- controlled and self-directed learning. The disadvantages of synchronous online learning include the learning process, technology issues and distraction. Whereas, social isolation, lack of interaction and technology issues are a few disadvantages related to asynchronous online learning. According to Duncan et al. [7], synchronous engagement has a larger positive effect on students' examination performance relative to asynchronous engagement. Another study by Skylar [8] compared synchronous and asynchronous lectures, it was found that both the modes of lectures were effective in terms of delivery. But 75% of students mentioned that they would rather take a synchronous lecture compared to an asynchronous lecture. According to Hrastinski [9], asynchronous online learning helps combine education with work, family and also helps students in refining their contributions which are considered more thoughtful compared to synchronous learning. Yamagata-Lynch mentioned in her study that "synchronous online whole class meetings and well-structured small group meetings can help students feel a stronger sense of connection to their peers and instructor and stay engaged with course activities" [10, p. 189]. Getting real time feedback from instructors and interacting with peers in a synchronous class increases students' engagement and sense of community [11], [12].

There is a limited literature base investigating different modes of online instruction in design thinking courses and, through this paper, we are trying to understand and share the effectiveness of different modes of online instruction in an active design thinking course. The main opportunity that drives this study is that in the global pandemic where students signed up for face-to-face interaction and instructors made an emergency transition to online instruction, how might we best engage students in the online environment? The results of the paper could

also help in this time of pandemic by shedding light on effective ways to teach highly active group-based classrooms for better student learning, social presence and learner satisfaction.

Research Context

This study was conducted in a freshmen level design thinking course offered in a midwestern university. This was a required course for Purdue Polytechnic freshmen students and was offered Fall, Spring, and Summer terms. Typically, there are eighteen sections of the course offered in Fall andSpring with around 500 to 700 students each term and in Summer, three sections of the course are offered with around 100 students. The format of the course is a flipped and active course, where all the course content is shared with students before the actual class through the learning management system which includes videos, reading materials, quizzes, and assignments. During the scheduled class time, there are active discussions and hands-on learning related to the learned course content. The design thinking course has three projects- the first two projects are small projects aimed to help students learn the design thinking process. The third project is a larger course capstone project where students apply the design process to solve a real time problem and come up with functional prototypes as a project outcome. All the projects are group-based projects and the final project groups are selected by students themselves based on their interest area for the project. To understand the context of this study, the next section describes a typical class meeting.

Daily Routine- Design Thinking Course

Students read and complete the assigned course work prior to the class meeting. During the actual class meeting (each meeting is 50 min long, twice per week for 16 weeks during the semester), the first 5 to 10 minutes of the class are dedicated for whole group discussion- where the instructor helps students understand the purpose and real time application of the learned material posted before class. The next 35 minutes are dedicated for small group work, where students sit with their respective groups and complete the in-class work which is a part of their project. During this time, the instructor would be present in class helping different students' groups in completing their work and answering questions. The last five minutes of class return to a whole group discussion, where the instructor reflects on the day's work and also talks about the next meeting and the preparatory work required prior.

This pattern generally continues for all the meetings except for the final project presentations. It is important to know that student groups also meet outside of class hours to work on projects and complete the prep work.

With the outbreak of COVID-19, there was a sudden shift in the design thinking course delivery in the Spring 2020 semester. In March 2020, the class was asked to meet online for the rest of the semester after the Spring break. The instructional team met before the Spring break to brainstorm on how to proceed the instruction during the online learning and finalized their individual approaches before resuming instruction after spring break. There were 18 sections of the course taught by seven different instructors in which most of the instructors were graduate

students. Three different approaches to online teaching emerged based on the instructor's creativity and how they thought they could optimally support learning for the duration of the term. Table 1 shows the three emerged online teaching approaches highlighting the primary the differences.

Table 1

Three emerged online teaching approaches in the design thinking course

Online Teaching Approach followed by different instructors	Synchronous Whole group orientation/instruction	Asynchronous Whole group orientation/instruction	Synchronous Teamwork	Asynchronous Teamwork
Fully Synchronous	✔		✔	
Partially Synchronous		✔	✔	
Asynchronous		✔		✔

Fully Synchronous Approach:

In our fully synchronous approach, the instructor met with students during class time through MS Teams software synchronously. During the class time, the whole group discussion was done in MS Teams general channel and small group work was done synchronously during the class time in the small group team channels. The instructor waited in the general channel to field questions from students or moved through the team channels by dropping in just like an instructor would field questions from a podium or when an instructor would walk up to a table of students working, listen in and offer support as needed. This approach was very similar to an actual class setting where everyone was oriented and working at the same time. Attendance was taken to ensure all students were engaged.

Partially Synchronous Approach

In our partially synchronous approach, the instructor pre-recorded the whole group orientation/introduction for the class including the instructions to complete the in-class and the next class prep work. The pre-recorded video was shared with students before the scheduled class time through the Learning Management System. Students watched the video on their own time but met synchronously with their respective groups during the scheduled class time to complete the assigned in-class assignment. The instructor was live during the scheduled class time ready to help students just like the fully synchronous approach.

Asynchronous Approach

In our asynchronous approach, the instructor pre-recorded the whole group discussion very similar to the partially synchronous approach and shared that with the students to watch and complete the work for the class. Students were expected to watch the orientation video and schedule a time with their small group to work on their projects together. In the asynchronous approach, instructors sent out email reminders but did not necessarily meet with students during the scheduled class time. Students may or may not have decided to get their "in class work done" during the scheduled class time. The deadlines remained the same assuming student teams were meeting twice weekly to complete the work. The instructors in this approach offered to meet with teams on an as needed basis regardless of the scheduled class meeting times. The instructors also had office hours where they were present to help any student with questions.

Research Methods and Data Collection

Method

The study follows a correlational research method as the purpose of the study was to measure the relationship between three different online teaching approaches and student experiences. Understanding the relationship between variables helps describe certain events, conditions, behaviors and even predict future outcomes [13]. Also, as the study is not having any pre-post comparison, it is a non-experimental design and correlation study design best fits the purpose. As per the literature, the teaching and learning environment has a significant impact on students' behavior, academic success and learning quality [16], [17]. And because of this, in our study, we measured the teaching learning environment from the transition to online (mid-semester) to the end of the semester based on three constructs: a) perceived student learning as a measure of academic success b) social presence as a measure of student engagement in an online environment and c) learner satisfaction as a measure of learning experience quality. We chose to measure perceptions because we sought to understand the student experience with the transition to online. We chose to measure perception of student learning as opposed to actual student learning (measured by grades or project quality) because learning spanned the entire semester while only about one-half of the term was online [due to COVID].

Instructor quality measured by previous course evaluation scores as represented in Table 2 revealed that all the seven instructors had prior teaching experience and generally comparable

teaching scores. Also, it is important to note that each section of the course had a similar number of students which ranged from 36 to 38 students per section.

Table 2

Instructors' teaching experience and teaching scores

Approach	**Instructor**	**Previous semester average teaching scores (1-5)**	**Previous teaching experience**
Fully Synchronous	Instructor 1	4.4	1 semester of teaching this course and 10 years of public- school teaching
	Instructor 2	4.45	9 semesters of teaching this course
	Instructor 3	4.8	6 semesters of teaching this course and 5 years of public-school teaching
Partially Synchronous	Instructor 4	4.4	1 semester of teaching this course and 11 years of public-school teaching
	Instructor 5	N/A	4 years of public-school teaching
Asynchronous	Instructor 6	4.7	7 semesters of teaching this course and 3 years of public-school teaching
	Instructor 7	4.3	3 semesters of teaching this course and 7 years of public college teaching

Data Collection and Instrument

Data were collected as an end of semester survey administered at the end of Spring 2020 semester (see Appendix A). The survey instructed the students to focus on their student experiences in the online portion of the design thinking course after the course switched completely to the online format which was the last 8 weeks of a 16-week term. The survey link was embedded into the meeting agenda for the last day of class for 666 students (population of the course that term) enrolled in the course in the Spring 2020 semester using Qualtrics. Three hundred and twenty-four students responded to the survey and, after removing the missing and incomplete data, the sample became 317 student responses. Out of the 317 responses, 185 student responses were from fully synchronous approach, 54 student responses were from partially synchronous approach and 78 responses were from asynchronous approach. We speculate that the main reason for higher response rate in fully synchronous approach could be because the instructors of the fully synchronous sections gave live in-class time during the last meeting to complete the survey compared to instructors of other approaches where it is mentioned in the recorded video introduction for the class. The student experience in the online design thinking course was measured based on three outcome variables- perception of student learning, social presence and learner satisfaction. Perception of student learning was measured using the survey instrument developed by Walker and Fraser [14]. Learning survey has 34 questions with Likert scale responses 1 to 5, where 1=Never, 2=Seldom, 3= Sometimes, 4= Often and 5= Always. Social presence and learner satisfaction survey was developed by Richardson and Swan [15] with five questions in each session. The survey question responses are measured through Likert Scale from 1 to 6, where 1= Strongly Disagree, 2=Disagree, 3=Somewhat Disagree, 4= Somewhat Agree, 5= Agree and 6= Strongly Agree.

The Distance Education Learning Environment Survey (DELES) was used to measure student learning as this survey was specifically developed and validated by Walker and Fraser [14] to assess the postsecondary distance education learning environment. The DELES survey has a Cronbach's alpha of 0.94 and as of January 2021, the survey has been used in three hundred and seventy-six other studies. Social Presence and Learner Satisfaction were measured using the survey scale developed and validated by Richardson and Swan [15]. The reliability for the survey is a Cronbach's alpha of 0.87 and has been cited by two thousand three hundred and eighty-eight authors as of January 2021.

Data Analysis

The survey responses were downloaded in an excel format from Qualtrics. Incomplete responses were deleted, and survey data were classified into different approaches. The classified data was loaded into SPSS for analysis. A one-way ANOVA was appropriate for this study because there were three or more independent groups [18]–[20]. In this study, the three approaches of online learning are the independent grouping variable and perception of student learning, social presence and learner satisfaction are the dependent variables. The results of one-way ANOVA would help understand if there is any significant difference between the three

approaches for the dependent variables. Where significant differences were discovered, a Tukey Post-Hoc analysis was conducted in SPSS to identify those specific differences by comparing means of the approaches to the mean of every other approach. A Kolmogorov-Smirnov test was done to check for normality. The social presence variable differed from normal. A homogeneity of variance test was run and the student satisfaction viable violated the assumption. A Kruskal Wallis test was run to confirm the ANOVA results specific to the social presence and student satisfaction variables due to their non-normal distribution and homogeneity violations. Based on the large sample size for all the variables and confirmation of Kruskal Wallis, the one-way ANOVA was run and reported here.

Results

The descriptive statistics and ANOVA results for the three dependent variables (perception of student learning, social presence and student satisfaction) are represented in Tables 3 to 8. For perceived student learning variables, the ANOVA results indicated that there was no significant effect $F(2,311)=1.03$, $p=.36$ for the three approaches. The social presence variable also did not show any significant effect $F(2,311)=1.32$, $p=.27$ for the three approaches of online teaching. However, for the third variable related to student satisfaction, a significant difference $F(2,310)=5.96$, $p=.003$ was observed between the three approaches. To further compare the means of the approaches to each other, a Tukey Post-Hoc test was conducted for the variable student satisfaction as shown in Table 9. The pairwise comparison of the means using Tukey indicated that students in fully synchronous approach ($M=4.16$) reported that their satisfaction were significantly more than students in partially synchronous approach ($M=4.13$, $p=.03$) and asynchronous approach ($M=4.05$,$p=.01$) with a 95% confidence interval of the difference between means from 0.29 to 0.73 for partially synchronous and from 0.07 to 0.68 for asynchronous on a 1 to 6 scale. We noticed in the descriptive statistics that not only did the fully synchronous approach have a higher mean for student satisfaction, it had a lower standard deviation as shown by the distributions in Figure 1a, 1b and 1c.

Table 3

Descriptives for Perception of Student Learning

	N	Mean	Std.Deviation	Std.Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Fully Synchronous	185	4.16	.57	.04	4.08	4.25	2.47	5.00
Partially Synchronous	52	4.13	.62	.09	3.96	4.30	2.44	5.00
Asynchronous	77	4.05	.55	.06	3.93	4.18	2.59	5.00
Overall	314	4.13	.57	.03	4.07	4.19	2.44	5.00

Table 4

ANOVA Perception of Student Learning

		Sum of Squares	df	Mean Square	F	Sig.
Student Learning	Between Groups	.68	2	.34	1.03	.36
	Within Groups	102.67	311	.33		
	Total	103.35	313			

Table 5

Descriptives for Social Presence

	N	Mean	Std.Deviation	Std.Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Fully Synchronous	185	4.94	.86	.06	4.81	5.06	1.60	6.00
Partially Synchronous	52	4.93	.94	.13	4.67	5.19	2.00	6.00
Asynchronous	77	4.75	.95	.11	4.53	4.96	1.80	6.00
Overall	314	4.89	.89	.05	4.79	4.99	1.60	6.00

Table 6

ANOVA for Social Presence

		Sum of Squares	df	Mean Square	F	Sig.
Social Presence	Between Groups	2.11	2	1.05	1.32	.27
	Within Groups	248.03	311			
	Total	250.14	313			

Table 7

Descriptives for Student Satisfaction

	N	Mean	Std.Deviation	Std.Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Fully Synchronous	185	4.98	.84	.06	4.86	5.11	2.00	6.00
Partially Synchronous	52	4.60	1.23	.17	4.26	4.95	1.20	6.00
Asynchronous	76	4.61	.99	.11	4.38	4.84	1.60	6.00
Overall	313	4.83	.97	.055	4.72	4.94	1.20	6.00

Table 8

ANOVA for Student Satisfaction

		Sum of Squares	df	Mean Square	F	Sig.
Student Satisfaction	Between Groups	10.85	2	5.42	5.96	.003
	Within Groups	281.95	310	.91		
	Total	292.80	312			

Table 9

Tukey Post – Hoc Student Satisfaction

(I)Approach	(J)Approach	Mean Difference(I-J)	Std.Error	Sig.	95% confidence Interval	
					Lower Bound	Upper Bound
Fully Synchronous	Partially Synchronous	.38*	.15	.03	.03	.73
	Asynchronous	.38*	.13	.01	.07	.68
Partially Synchronous	Fully Synchronous	-.38*	.15	.03	-.73	-.03
	Asynchronous	-.00	.17	1.00	-.41	.40
Asynchronous	Fully Synchronous	-.38*	.13	.01	-.68	-.07
	Partially Synchronous	.00	.17	1.00	-.40	.41

*. The mean difference is significant at the 0.05 level.

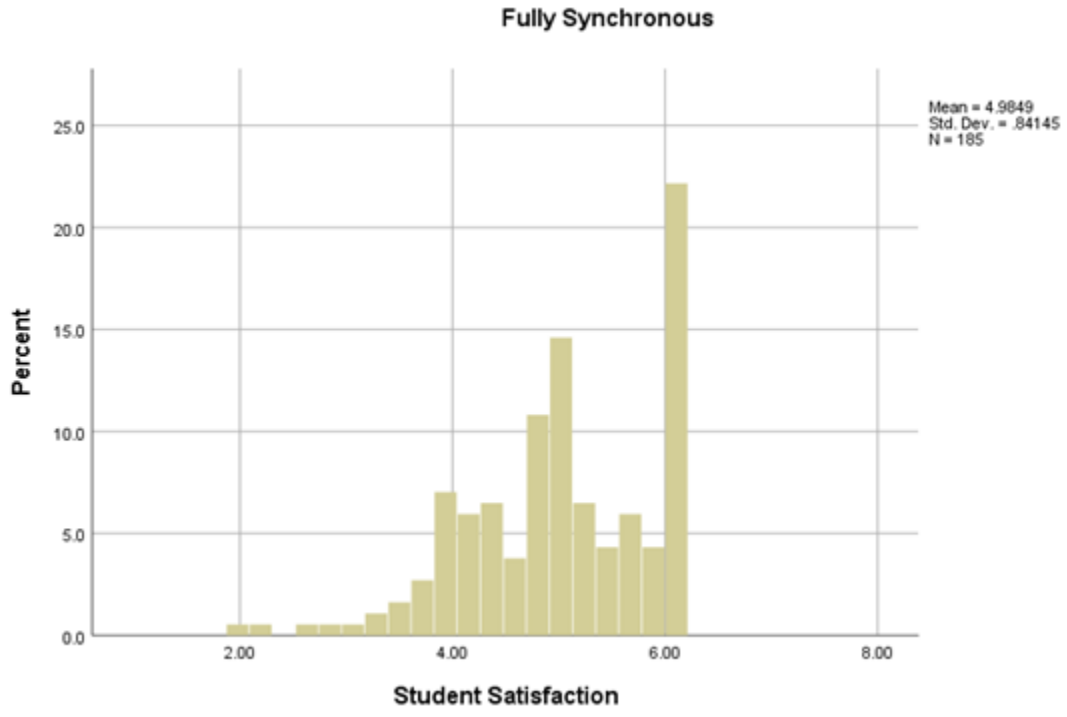

Figure 1a. Representation of Student Satisfaction for Fully Synchronous Approach

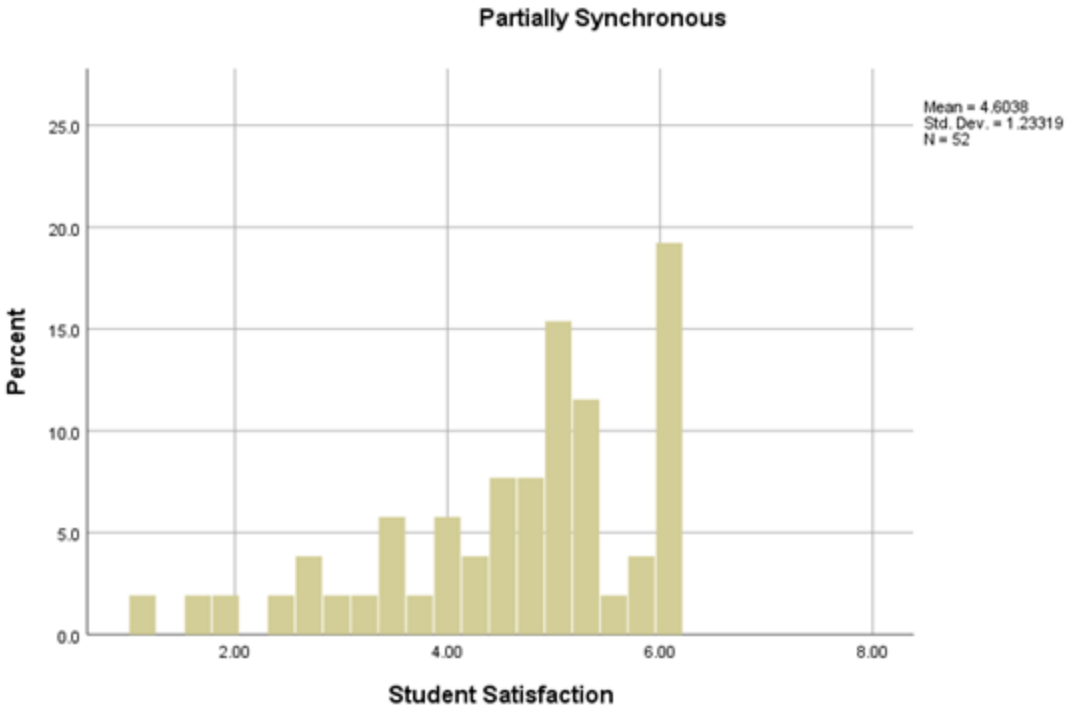

Figure 1b. Representation of Student Satisfaction for Partially Synchronous Approach

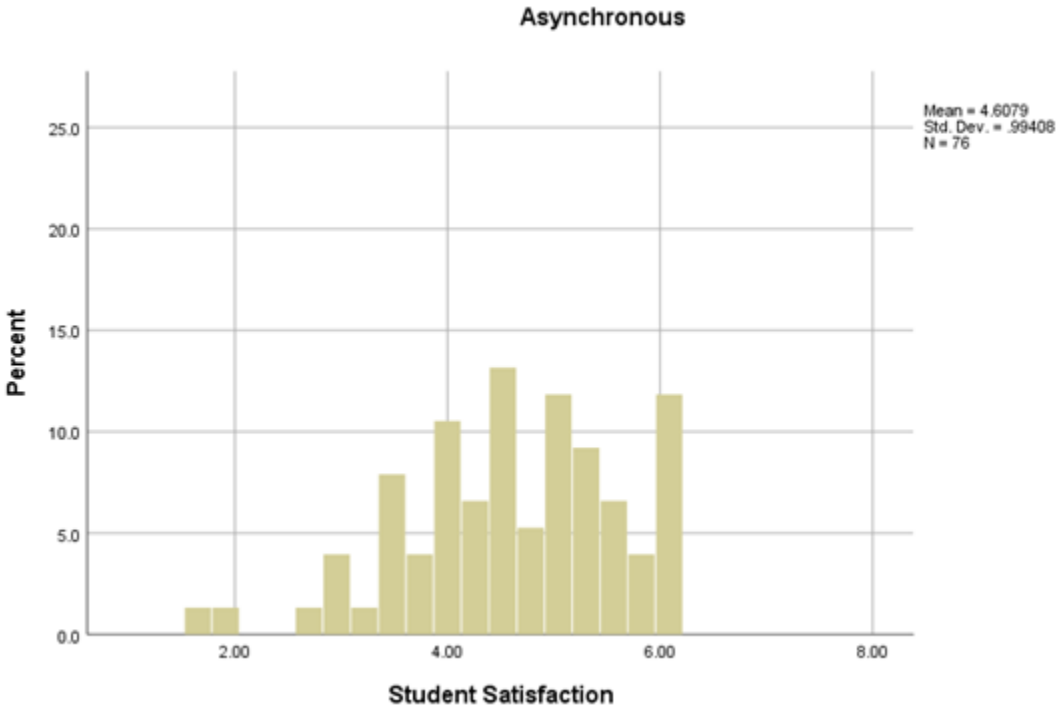

Figure 1c. Representation of Student Satisfaction for Asynchronous Approach

Discussion

With the sudden outbreak of COVID-19, the instructors of a freshmen level design thinking course were asked to transition the course to an online only format in the middle of the Spring 2020 semester which gave us a chance to investigate three different teaching modes as they emerged. Different instructors chose to teach online in different formats based on their preferences and what they anticipated might be most helpful for students. In a 'fully synchronous' approach, the whole group and small group discussions were synchronous in nature. In a 'partially synchronous' approach, the whole group orientation was asynchronous, and the small group work was synchronous and in an 'asynchronous' approach, both whole group and small group discussions were asynchronous. Student experiences in the three different modes of online teaching were not significantly different for perceptions of student learning and social presence. Learner satisfaction, however, did differ significantly.

A significantly higher mean score and slightly smaller standard deviation of fully synchronous approach indicated not only that students were more satisfied on average, but student responses were more tightly clustered near the mean. Therefore, fewer students had extremely low satisfaction scores. In other words, this approach was less polarizing and provided a more similar student satisfaction experience across more students than did the other approaches.

Call to Action

During and beyond the COVID pandemic, these results may inform online teaching approaches because project-based learning is well established, and online learning is becoming more widely available. These results suggest that as faculty consider optimizing their teaching time, if they have one or only a few sections of students, they might teach live with the students providing an interactive discussion synchronously while students work synchronously (fully synchronous approach) to maximize learner satisfaction while maintaining perception of learning and student social presence. If instructors have multiple sections, they might gain efficiency by recording one orientation talk and allowing students to play it (thus saving time by not repeating the same talk for each section). If instructors do record the orientation talk, student perception of learning and social presence may not differ from a synchronous experience, but learners may be less satisfied. Addressing the student satisfaction issue may be related to controlling expectations so they understand how the class will be run or may be supplemented in other ways yet to be explored. If the instructor chooses to record the orientation talk, we discover no differences between perceived student learning, student social presence or learner satisfaction related to when students work - whether all students are working at the same time (determined by the class meeting schedule) or on their own schedules.

Future research may seek to understand why each of these approaches had similarities and yet there were some differences through analysis of students' written comments. If students are prompted in the surveys to explain their quantitative responses, we might begin to understand why they responded as they did. By interviewing instructors who taught different approaches might also help understand in depth what they did in their respective teaching approach and how

this would impact student satisfaction. We also suggest investigating learning more directly rather than the perception of learning as some students may not be able to accurately gauge their own learning. Perception of learning is important for student persistence, but actual student learning is important for mastering prerequisite skills needed in future classes and work.

Our study has a few limitations worth considering. First, instructors choose the approach they used, and all sections taught by that instructor used the same approach. Therefore, we cannot parse out the impacts of instructor personality or teaching style from the impacts of the approach. Second, this study focused on the second 8 weeks of a 16-week term. Relationships and routines were established prior to transitioning to an online environment may impact student perceptions, social presence, and satisfaction. Though our study has these limitations, we find the results informative of our future online decision making and research into online student learning.

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Appendix A

Online Course Evaluation Survey Questions

Student Learning

Response Scale: 1= Never, 2= Seldom, 3= Sometimes, 4= Often, 5= Always

1. If I have an inquiry, the instructor finds time to respond.
2. The instructor helps me identify problem areas in my study.
3. The instructor responds promptly to my questions.
4. The instructor gives me valuable feedback on my assignments.
5. The instructor adequately addresses my questions.
6. The instructor encourages my participation.
7. It is easy to contact the instructor.
8. The instructor provides me with positive and negative feedback on my work.
9. I work with others.
10. I relate my work to other's work.
11. I share information with other students.
12. I discuss my ideas with other students.
13. I collaborate with other students in the class.
14. Group work is a part of my activities.
15. I can relate what I learn to my life outside of university.
16. I am able to pursue topics that interest me.
17. I can connect my studies to my activities outside of class.
18. I apply my everyday experiences in class.
19. I link class work to my life outside of university.
20. I learn things about the world outside of university.
21. I apply my out-of-class experience.
22. I study real cases related to the class.
23. I use real facts in class activities.
24. I work on assignments that deal with real-world information.
25. I work with real examples.
26. I enter the real world of the topic of study.
27. I explore my own strategies for learning.
28. I seek my own answers.
29. I solve my own problems.
30. I make decisions about my learning.
31. I work during times that I find convenient.
32. I am in control of my learning.
33. I play an important role in my learning.
34. I approach learning in my own way.

Social Presence

Response Scale: 1= Strongly disagree, 2= Disagree, 3= Somewhat disagree, 4= somewhat agree, 5= Agree, 6= Strongly agree

1. I felt comfortable conversing through this medium/in class.
2. I felt comfortable participating in course discussions.
3. I felt comfortable interacting with other participants in the course.
4. I felt that my point of view was acknowledged by other participants in the course.
5. I was able to form distinct individual impressions of some course participants.

Learner Satisfaction

Response Scale: 1= Strongly disagree, 2= Disagree, 3= Somewhat disagree, 4= somewhat agree, 5= Agree, 6= Strongly agree

1. The instructor created a feeling of community.
2. The instructor facilitated discussions in the course.
3. My level of learning that took place in this course was of the highest quality.
4. Overall, this course met my learning expectations.
5. Overall, the instructor for this course met my expectations.