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Survey Design for Evaluating Student Interaction in Face-to-Face and Online Learning Environment

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Abstract

Social learning is an important part of the college experience. With the rapid transition from face-to-face to online courses after COVID-19, the instructors were challenged with creating an online learning environment that supports social interaction for students. This project investigates the use of technology for interaction by the instructors, and how the students adapted technologies that allowed them to keep their interactions alive in the online courses. A 15-minute online survey was designed at a large engineering school in the southwestern United States. The undergraduate and graduate students in engineering who were enrolled in STEM courses in summer 2020 were invited to complete the survey at the end of the summer. Due to the online nature of the summer semester, this survey included separate questions for the students who took synchronous or asynchronous courses. The survey included both qualitative and quantitative questions.

This research paper explains the survey design and the type of results obtained from the survey. To assess the student interaction with instructors/Teaching Assistants and with other students in online courses, the students answered questions related to (i) technology/platforms used by their instructor, (ii) methods used by their instructor, (iii) how the students adapted their interaction in the online environment, (iv) average time spent interacting each week, and (v) the satisfaction ratings on a Likert scale. For comparing with face-to-face courses (pre-COVID-19), the students were also asked to explain their interaction with instructors/Teaching Assistants and with other students in the face-to-face courses taken in fall 2019, and the average time spent interacting each week. The demographic questions included the student classification, engineering major, gender, ethnicity, the highest level of education completed by parents, and whether they were an international student. The results from this survey will play an important role in our understanding of how the students adapt from face-to-face courses to the online learning environment. Zoom and eCampus were the most commonly used tools for interaction in online courses. The virtual study groups and live interaction were widely used methods for students to interact with each other in online courses.

Introduction

With the rapid transition from face-to-face to online courses after COVID-19, the instructors at colleges and universities in the United States and other countries were challenged with creating an online learning environment that supported student learning. Learning is a social process where students interact with each other for the exchange of knowledge and for building a community of inquiry [1-3]. Social learning is also an important part of the college experience for many students where informal learning happens among students in their courses and student organizations. Since March 2020, the students have been experiencing a loss of interaction with their instructors and with other students which has impacted their ability to learn in online

courses [4-6]. Previously, the lack of social interaction has been reported as a weakness for many online courses which prevents students from learning effectively in an online environment [7-8]. Further, both the student-instructor and the student-student interactions are positively associated with student satisfaction and perceived learning in a technology-mediated environment [9]. This means that the deliberate use of technology for enhancing student-instructor and student-student interactions could help overcome the lack of social interaction in online courses, thereby improving student satisfaction and perceived learning. In recent studies, the use of collaborative [10] and personalized [11] tools and methods in online learning environments has been shown to promote student interaction and learning.

The goal of this research is to investigate which tools—technology and platforms—and methods promote student interactions in the online learning environment. This study was student-centered and gathered data from engineering students at a large engineering school in the southwestern United States. Because of the wide variety of videoconferencing technology, communication platforms, and learning management systems that are available for use by the instructors and students, their impact on student interactions for social learning needs to be carefully considered. In this study, **technology** or **platforms** refer to the specific product or service names whereas **methods** refer to the general strategy used to accomplish specific objectives. For example, in the entertainment industry, Netflix, Hulu, or Amazon Prime Video are the technologies or platforms; On-demand streaming, Movie theater, or Cable TV are the methods.

We are interested in answering the following research questions through this study:

1. Which technology/platforms and methods were being used by the instructors to manage the student interactions in online STEM courses and the extent of social interaction in those courses?
2. How were students adapting and adopting technologies to manage their interactions with the instructors/Teaching Assistants (TAs) and with other students in online courses and the satisfaction associated with those interactions?
3. How did the student interactions in online courses compare to their interactions in face-to-face courses?

To answer the research questions using an evidence-based approach, a survey was designed and tested as described in this paper. The survey was used to examine how students adapted and adopted technologies that enabled them to keep their student interactions alive in the online learning environment. The analysis of this survey data will help discover technology/ platforms and methods that can provide effective student interactions for online and distance engineering courses. While this paper focuses on the development and testing of the survey, the results of data collected from this survey will be shared in detail in a separate paper [12]. We

hope this study and the survey will help in driving the adoption and integration of student interaction tools and methods in future STEM courses.

Theoretical Background

Among many learning theories that have been developed, the social cognitive learning theory developed by Albert Bandura is used as the theoretical foundation for this study. It incorporates the elements of behavioral and the cognitive aspects of learning such as attention, motivation, and memory functions [13-14]. According to this theory, the learning outcomes depend on three factors:

(a) personal factors: internal cognitive factors based on knowledge and attitude
(b) behavioral factors: outcome expectations influenced by observable behavior in others
(c) environmental factors: social norms, community access, social support, and barriers

The social cognitive theory was applied to this study to explain the relationship between an individual student, the peers or instructor/TA, and the learning environment. A visual illustration modeling this relationship is shown in Figure 1. The individuals can self-regulate their learning process for exchanging knowledge by interacting with the peers or instructor/TA, which is defined as '*student interaction*' in this study. The learning environment and educational policies can also influence the learning process.

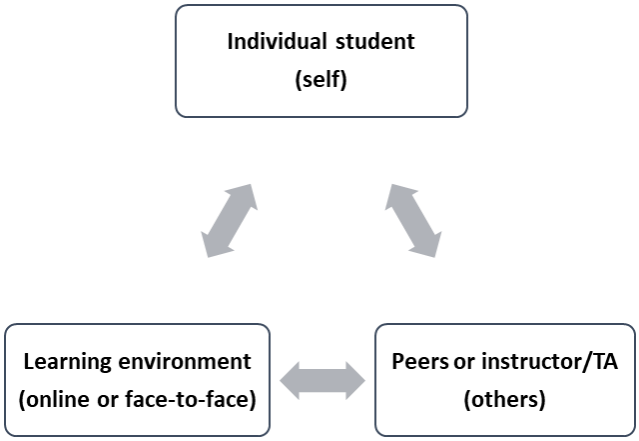


Figure 1: Relationship between individual student, peers or instructor/TA, and the learning environment. Model adapted from Bandura's social cognitive learning theory [13-14].

In this study, to evaluate the tools and methods used for student interactions in the online learning environment, the design of the survey would need to consider the following factors:

1. Identify tools and methods - Which technology/platforms and methods are being used?
2. Measure engagement - How much did the students interact with each other using those tools and methods?
3. Evaluate satisfaction - What was the quality and effectiveness of student interactions using those tools and methods?

Methods

I. Survey design

The survey was designed and administered using the Qualtrics online software after approval from the Institutional Review Board (IRB). This mixed-methods survey with qualitative and quantitative questions was designed to be completed in 10-15 minutes. A flow diagram shown in Figure 2 illustrates different sections of the survey, and the complete survey is attached in Appendix. Based on the type of online courses that were offered, the survey structure had parallel blocks such that the students could answer the questions related to either the synchronous or the asynchronous courses they were taking.

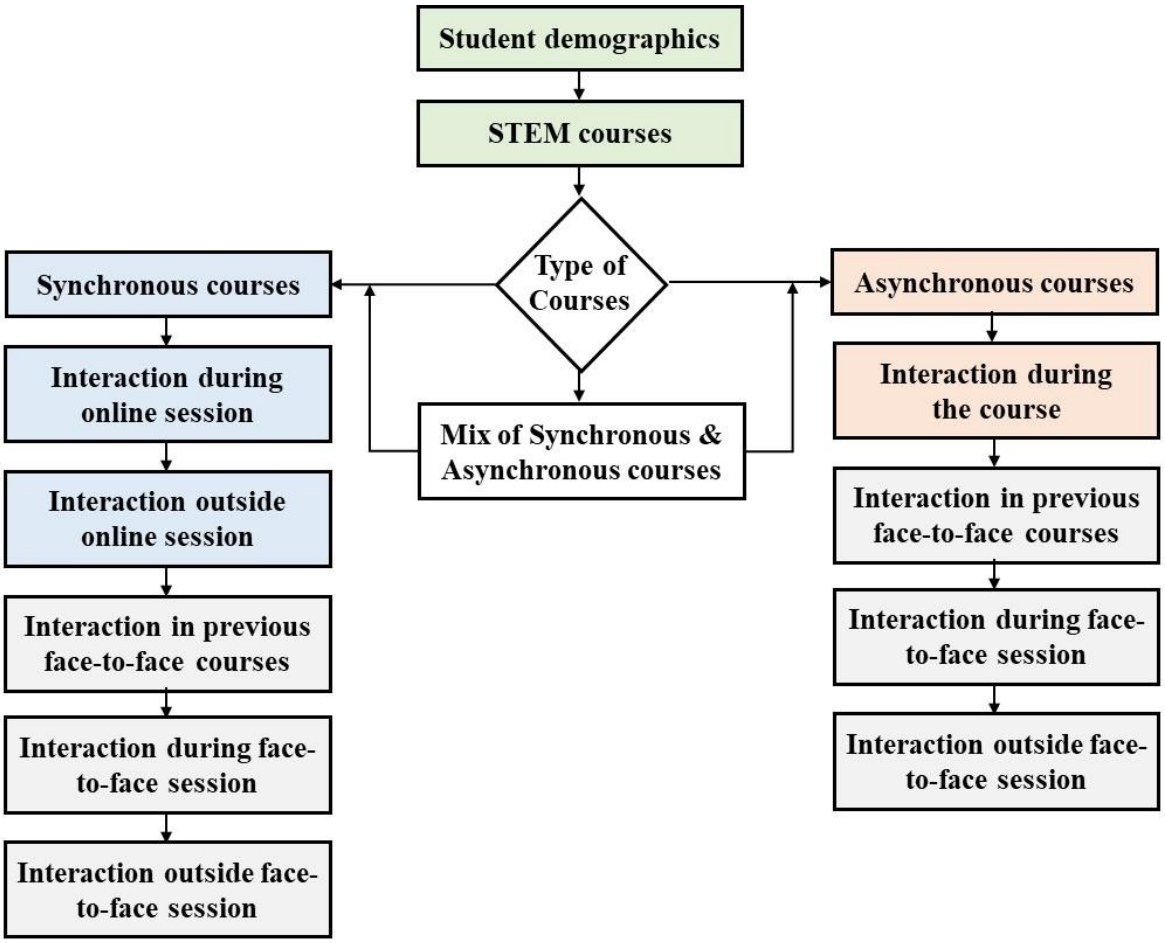


Figure 2: Flow diagram showing components of the survey including the student demographics, STEM courses, type of courses, interaction in synchronous *or* asynchronous courses, and the interaction in previous face-to-face courses.

<u>Student demographics and STEM courses</u>: The initial section of the survey asked students about their demographic information such as the student classification, engineering major, gender, ethnicity, the highest level of education completed by parents, and whether they were international student. Once the students completed the demographic section of the survey, they

were asked to list the STEM courses that they took in the summer 2020 semester which was fully online. This was one of the questions that was used to ensure that our survey results will be valid for STEM disciplines.

Type of courses: In summer 2020, the online courses offered were synchronous and asynchronous, therefore the students were asked in the survey to report the type of courses they were taking by selecting one of the three options: *synchronous*, *asynchronous*, or *a mix of synchronous and asynchronous* courses. For clarity, the students were also provided with the definitions of synchronous and asynchronous course within the survey: "In **synchronous course**, the instructors and students are required to be online in real-time. In **asynchronous course**, the instructors and students are required to be online but NOT in real-time." Depending on the option that the student selected, they would be taken to the survey for either the synchronous or asynchronous courses. If a student selected the third option for mix of synchronous and asynchronous courses, they were then prompted to select either the synchronous or asynchronous courses that they were going to report in the remaining survey questions. The remaining portion of the survey was split into either synchronous or asynchronous courses.

Synchronous courses: Because a synchronous online course has sessions in real-time during the course and may have outside components, the students were asked the following qualitative questions about their interaction *during the online session* as well as *outside the online session* – (i) the technology/platforms that the instructors used, (ii) the methods that the instructors used, (iii) how the student interacted with instructors/TAs, and (iv) how the student interacted with other students. The students were also asked to provide the amount of time they spent each week for each of the qualitative questions. Finally, the students were asked to provide a satisfaction rating on a Likert scale of 1 to 5 for their interaction with both—the instructors/TAs, and with other students—*during the online session* as well as *outside the online session*. It is important to note that for clarity, the difference between technology/platforms and methods was defined throughout the survey with examples from the entertainment industry.

Asynchronous courses: Since the student can complete these pre-built online courses at their own time and pace, the students were asked the following qualitative questions about their interaction *during the course* – (i) the technology/platforms that the instructors used, (ii) the methods that the instructors used, (iii) how the student interacted with instructors/TAs, and (iv) how the student interacted with other students. Similar to the synchronous portion of the survey, the students for asynchronous courses were also asked to provide the amount of time they spent each week for each of the qualitative questions. To measure satisfaction, the students were asked to provide a rating on a Likert scale of 1 to 5 for their interaction with both—the instructors/TAs, and with other students—*during the course*. Again for clarity, the difference between technology/platforms and methods was defined throughout the survey with examples from the entertainment industry.

Face-to-face courses: This type of course typically has an in-person session, and may have outside components to the course. There were no face-to-face courses offered in the summer 2020 semester, however, the students were asked to reflect on their interaction in face-to-face courses from the fall 2019 semester. The students were asked the following qualitative questions about their interaction *during the face-to-face session* as well as *outside the face-to-face session* – (i) how the student interacted with instructors/TAs, and (ii) how the student interacted with other students. Similar to previous sections of the survey, the students were asked to provide the amount of time they spent each week for each of the qualitative questions.

Lastly, the students were provided an open-ended text box in the survey to provide any additional information about their interaction in online or face-to-face courses.

II. Population

The target audience for this survey were engineering students who were enrolled in the summer 2020 semester. Even though the primary audience was the undergraduate engineering students, this survey was also received by some graduate students when the courses were cross-listed for both the graduate and undergraduate students. At least 327 students opened the survey, while 315 of them accepted to fill out the survey and 93 eventually completed it (completion rate = 29.5%).

III. Survey distribution

The survey was emailed by the College of Engineering at our institution to all the undergraduate (and some graduate) students enrolled in engineering courses in the summer 2020 semester. The invitation email for the survey was sent at the end of the summer semester, followed by the first and the second reminders with a gap of four days between each.

Results

The accuracy of this survey was ensured by getting it reviewed by an external researcher and by conducting a small-scale pilot test before sending it to the engineering population for large-scale testing.

I. Survey Testing

Step 1: External review – The survey was sent for review to an external researcher who has published multiple papers related to human-subjects research, especially by conducting a survey. The initial version of the survey was revised for clarity and to eliminate subjectivity in a few question prompts. This test was adapted from the face and content validity described in [15].

Step 2: Pilot testing – The survey was completed by 10 student participants. From the survey responses that were received, the type of actual responses matched the range of expected responses from the survey, which confirmed the readability of survey questions. Next, the survey

questions were re-organized to make the survey easy to use based on the student comments. This test was adapted from the face and content validity described in [15].

Step 3: External review – The revised version of the survey was again reviewed by the same external researcher from step 1, and then approved.

Step 4: Large-scale testing and data quality – The final survey was completed by 93 student participants. The synchronous and asynchronous survey data were analyzed separately.

Since the responses to open-ended qualitative questions included the tools (technology/ platforms) and methods, the accuracy of these questions could be determined based on the responses received. The accuracy of qualitative questions about tools and methods was found to vary between 91 to 100%. For example, the accurate responses for this study included 'Zoom' and 'eCampus' for tools, and 'lecturing' and 'annotation' for methods. The "N/A" or "None" responses were also considered accurate for tools and methods. The inaccurate responses for tools and methods were the non-descriptive responses which included numbers, symbols, or text with no relevance to the question.

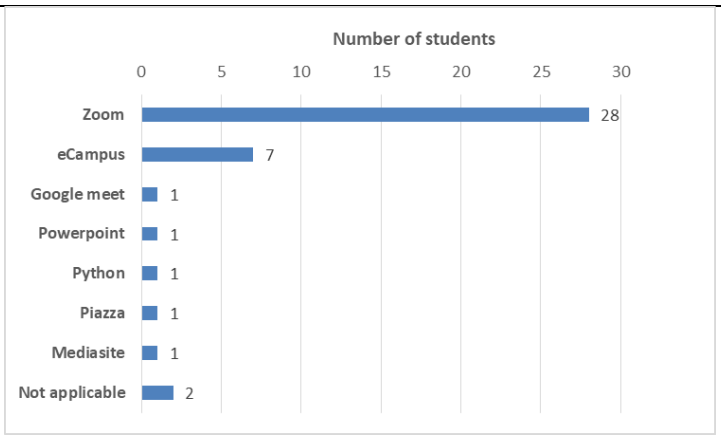
For the questions about time spent, the open-ended responses were converted to numerical values. For example, minutes were converted to hours ("3 hours and 45 minutes" → 3.75 hours), the range of values converted to a median value ("1-2" → 1.5; less than 1 → 0.5), multiple hours for different tools used by a student were combined to a single value ("4, 2, 2, 1" → 9), and non-relevant text were ignored. The data completeness of questions about time spent was calculated to be above 89% after converting responses to numerical values.

The responses for closed-ended satisfaction questions varied from "Extremely satisfied (5)" to "Extremely dissatisfied (1)."

II. Survey Responses from large-scale testing

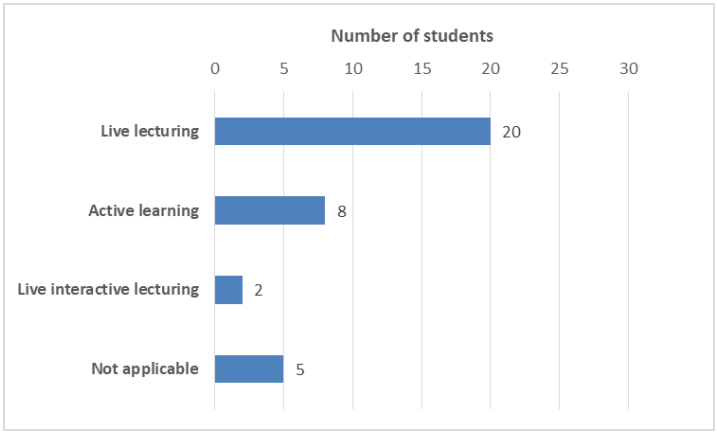
Out of 93 total responses, 2 participants' responses were ignored because those students did not take the STEM courses in summer 2020 semester. A summary of some of the survey responses is shown below in the form of word clouds. Next to the word cloud are categories obtained from coding and analyzing the qualitative data. Further results will be discussed in detail in [12].

Synchronous courses (n = 34)
Interaction during the online session
Question: What technology or platforms, if any, did your instructors use for interaction during the online session?



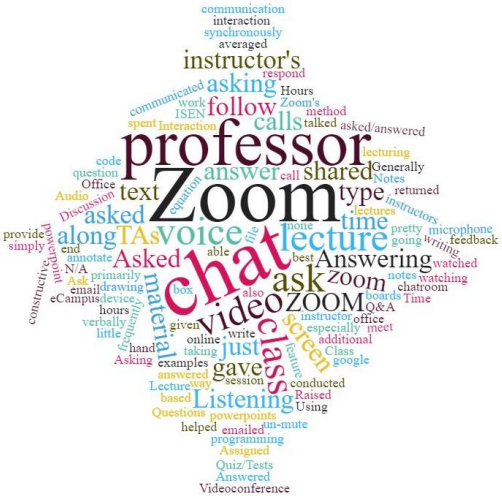
Time spent: 5.79 hours per week (mean), 4 hours per week (median)

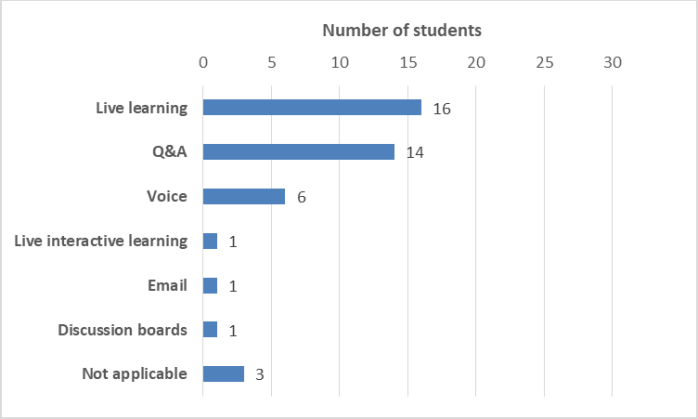
Question: What methods did your instructors use for interaction during the online session?



Time spent: 4.68 hours per week (mean), 3 hours per week (median)

Question: Brief explanation of how you interacted with the instructors and/or TAs during the online session.

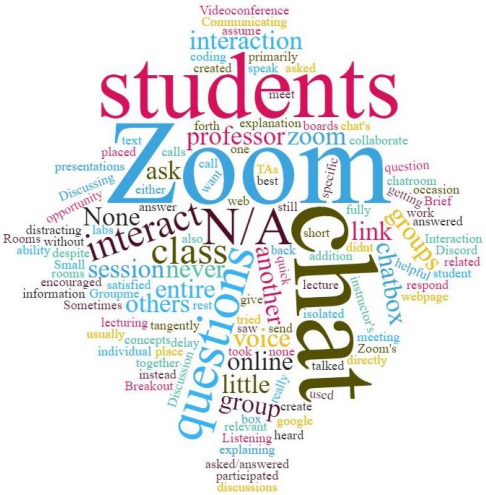


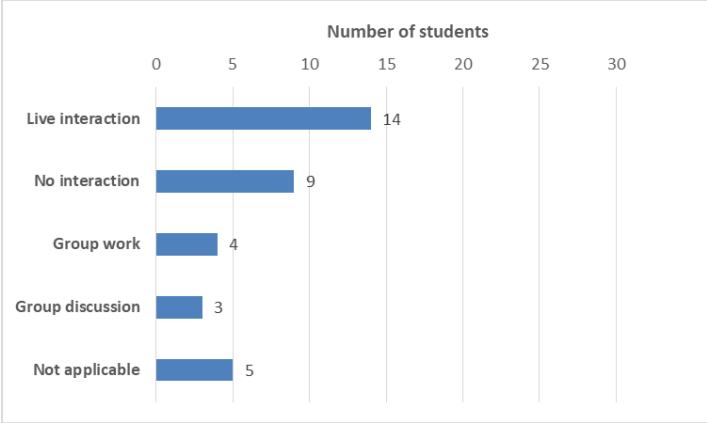


Time spent: 3.46 hours per week (mean), 2 hours per week (median)

Satisfaction: 4 (median), 4 (mode)

Question: Brief explanation of how you interacted with other students during the online session.



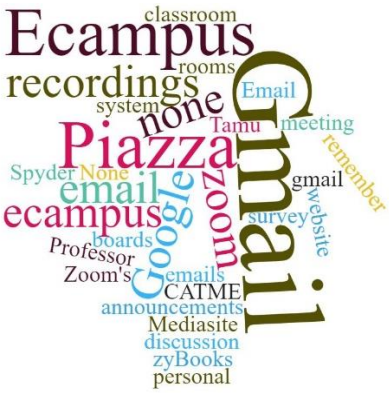


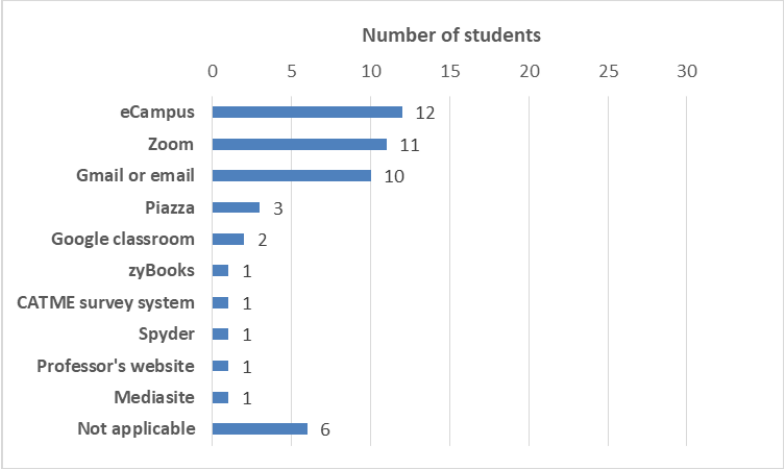
Time spent: 1.89 hours per week (mean), 0.5 hours per week (median)

Satisfaction: 4 (median), 3 (mode)

Interaction outside the online session

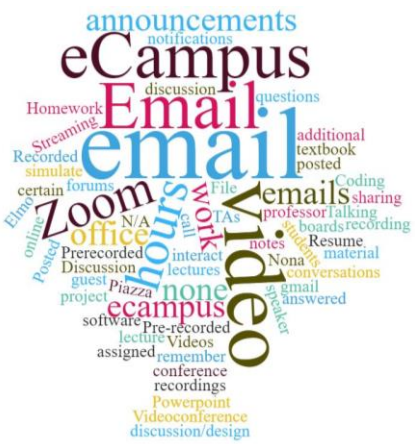
Question: What technology or platforms, if any, did your instructors use for interaction outside the online session?

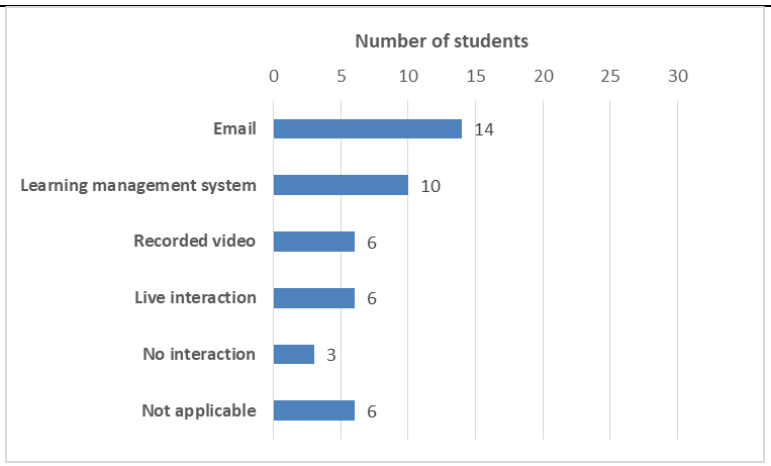




Time spent: 2.15 hours per week (mean), 1 hours per week (median)

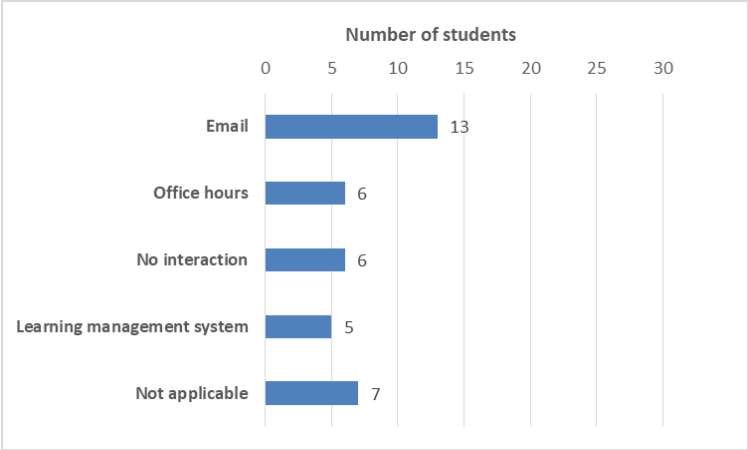
Question: What methods did your instructors use for interaction outside the online session?





Time spent: 1.99 hours per week (mean), 1 hour per week (median)

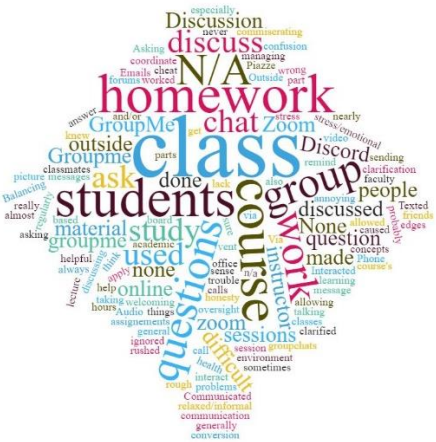
Question: Brief explanation of how you interacted with the instructors and/or TAs outside online session.

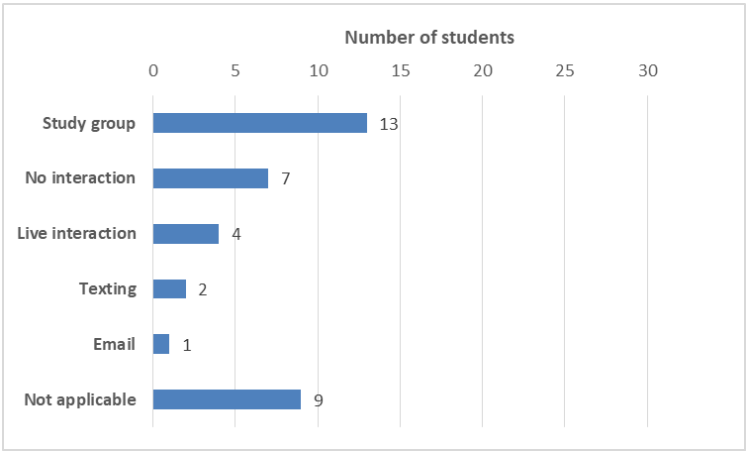


Time spent: 1.34 hours per week (mean), 1 hour per week (median)

Satisfaction: 4 (median), 5 (mode)

Question: Brief explanation of how you interacted with other students outside online session.





Time spent: 1.24 hours per week (mean), 1 hour per week (median)

Satisfaction: 4 (median), 4 (mode)

Discussion and Conclusion

The survey responses showed that the students used a combination of tools (technologies/platforms) for managing their interactions with instructors/TAs and with other students in online courses. The most commonly used tools in online courses were Zoom and eCampus. In synchronous courses, the method that was widely used by students to interact with instructors/TAs was live learning, and with other students was the live interaction. Outside the synchronous session, the students interacted with instructors/TAs using email and virtual office hours while they interacted with other students through the virtual study groups.

The survey was found to have a slightly low completion rate of 29.5% due to multiple open-ended response questions included in the survey. This makes it feasible for use in medium to large-scale exploratory studies at big institutions, or in larger-sized collaborations. The survey completion rate can vary depending on many factors including the survey length, question difficulty, and question type—multiple-choice or open-ended questions [16]. Similarly, the survey response rate depends on the content and presentation of questions, survey method and software, invitation design, and incentives [17]. In the future, this survey could be modified to have closed-ended response questions to increase the completion rate. The closed-ended categories for response could be based on the initial results obtained from the open-ended survey. This may allow the future survey participants to quickly select the multiple options for tools and/or methods, and list the remaining responses by selecting the "Other" option. The closed-ended survey would also lower the time required for data analysis as compared to an open-ended survey. Nonetheless, the administration of open-ended survey is an important first step for exploratory study to understand the emergent categories of tools and methods.

The large-scale testing of the survey shows that student responses closely match the expected range of responses. The survey can be validated through further testing in the future with different populations. Because of the qualitative nature of responses collected in the survey, we plan to further validate the results by conducting focus groups for the engineering population in the future.

This paper presented the survey design and testing in order to investigate the student interaction with instructors/TAs and with other students in online courses. To assess the student interaction with instructors/TAs and with other students in online vs. face-to-face courses, the students who took summer 2020 courses were asked to take an online survey which asked questions related to summer 2020 (online courses) and fall 2019 (face-to-face courses). The survey questions were related to tools and methods used for interaction, the amount of time spent for interactions, and the satisfaction associated with those interactions. The demographic information was collected to understand the effect of student interaction on different demographics.

The results from this survey will play an important role in our understanding of how the students adapt from face-to-face courses to the online learning environment. These evidence-based findings will imply that the use of technologies that enabled student-to-student and student-to-instructor interactions will be strongly encouraged for future courses. The use of virtual office hours for all courses is strongly recommended. In the future, this survey can be used to study student interactions in the online learning environment as the instructional technologies evolve and the modes of interaction change over time. For example, the students from the digital generation are more likely to communicate via Slack, GroupMe, and other messaging platforms compared to the previous generation of college students who used emails for primary communication. Similarly, the students from the digital generation are more likely to attend virtual office hours compared to previous students who attended office hours in person. This open-ended survey can also be adapted for longitudinal studies to track the changes in tools and methods for student interaction over time, enabling the innovation and discovery of digital interaction technology and platforms for higher education in the future.

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