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Activating and Engaging Students in Online Asynchronous Classes

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Activating and engaging students in online asynchronous classes

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Abstract

During the recent pandemic many instructors had to rapidly transform their in-person classes and adapt with the online teaching environment. This transition from in-person to online teaching modality raised challenges for both instructors and students. The lack of interactions either between instructors and students or between students themselves was reported to impact the quality of student learning experience and knowledge acquisition in online courses. This paper studies a discussion-based learning tool specifically designed for online asynchronous classes to promote student engagement and facilitate interactions. The developed online discussion platform served as an engagement tool with the purpose of initiating a multimodal communication hub for a diverse group of students located in different geographical locations and time zones. The preliminary measurements of the learning outcomes indicated the effectiveness of using such educational tools to close the learning gap between online and in-person classes. In addition a survey conducted to study the mediators that both contribute to and inhibit students participation in the online discussion. The strategies and tools discussed in this study could be inspiring for instructors as to how they may repurpose the available resources and learning tools to maximize their instructional practice.

Keywords: online teaching, discussion based learning, interaction, participation, activity

Introduction and Motivation

Before the pandemic, most of the core introductory engineering courses at Missouri S&T were offered as face-to-face courses, either in a traditional or flipped format, which relied extensively upon student-student and instructor-student interactions. During the recent pandemic, many instructors had to rapidly transform their face-to-face classes due to campus closures.This transition from in-person to online teaching modality raised challenges for both instructors and students. A survey conducted at Missouri S&T revealed that the main complaint expressed by students, after switching to the online settings, was the lack of interactions either between instructors and students or between students themselves. These findings align with other reported studies [1] on the impact of the recent pandemic on students' learning experiences. During the rapid transition from in-person courses to the online format, many instructors had to eliminate previously designed in-class activities that were proven to be effective in engaging students in class [2-4]; others had to adapt activities based on the limitations imposed by the available learning management systems (LMS).

There are several studies related to the challenges that students and instructors experience in online settings, and there are also some suggestions for the discussed problems. Some studies [4,5] focus on the role of institutes and suggest that it is the responsibility of the institutes to provide professional development training for instructors and to provide support for the development of online course content. Politis and Politis [6] studied the relationship between an online synchronous learning environment and knowledge acquisition skills and traits, concluding that the employment of additional online interactive tools might enhance learners' motivation and determination towards online learning. Ishii et. al. [7] and Kenzig [8] reported that many instructors and students often regard in-person courses as more engaging and effective than online courses due to the perceived face-to-face interactions. Other studies [9,10] discussed the struggles students experienced when taking online classes and the quality of learning experience and knowledge acquisition in the online courses. In summary, many of these studies highlight the impact of student-student and instructor-student interaction on the quality of student learning experience and knowledge acquisition in online courses.

The lack of interaction in online teaching is arguably more pronounced in engineering courses, where learning outcomes often involve development of problem solving skills. Active learning activities - reported by many instructors [2,3,11] to be an effective way to engage students in their learning process - are seemingly difficult, if not impossible, to implement in an online environment. The key component of in-class problem solving active learning activities is student-student interaction that allows participants to work together towards finding the solutions to complex problems by sharing ideas, spotting and correcting each other's mistakes, receiving feedback from the instructor, and teaching concepts and learning to/from each other. The lack of such interaction in the online classes, specifically in the online asynchronous classes, may prevent students from staying engaged and motivated during the semester.

To foster an interactive learning environment, instructors need to become aware of how interaction works as a mediator, and how it is best curated. Wagner [12] defined interactivity as consisting of "reciprocal events that require at least two objects and two actions. Interactions occur when these objects and events mutually influence one another". Chang [1] mentioned that an instructor's approach to instructional interactivity has important implications for online teaching. Furthermore, Bickle et.al. [13] reported that when students are required to interact, even in an asynchronous setting, they are more willing to share their thoughts and learn from other peers. A review of the current literature outlined general guidance on the development of online courses, however, there are a limited number of studies available on the implementation of online discussion in asynchronous problem-solving courses. It is generally agreed upon that initiating interaction and engagement is a great challenge for instructors of asynchronous courses and thus is an area in need of further research. For instance, while a video conferencing tool with the option of opening breakout rooms for small group discussions or think-pair-share activities can be utilized for online synchronous teaching, they are not practical in the asynchronous context as there is no common meeting time to synchronize group activities.

The development and implementation of an online discussion platform was motivated by restrictions imposed by the COVID pandemic that appeared to negatively affect student performance in class, interest in the subject, and sense of inclusion. To address the limitations imposed by the COVID pandemic, an online asynchronous section of Mechanics of Materials was developed in parallel with the in-person sections. The overall goal was to ensure that face-to-face and online sections obtained the same learning outcomes. Emphasis was placed on preserving the strengths of the face-to-face courses in the online sections, including the valuable student-student and instructor-student interactions. An online discussion platform was designed and implemented to overcome the stated asynchronous communication barrier by providing a communication outlet and facilitating problem-solving oriented discussion.

This paper presents the preliminary results of the implementation of an online discussion platform to facilitate student-student and instructor-student interactions in an online asynchronous course. The collection of data with which to measure the achievement of learning outcomes in the online course and compare them with in-person course achievements is ongoing. Despite the evolving nature of this study, the preliminary results are promising.

Methodology and implementation

The online discussion was implemented in the context of Mechanics of Materials, which is a sophomore-junior level required introductory course in various engineering disciplines. Mechanic of Materials, similar to many other core engineering courses, involves numerous problem solving activities. In the online asynchronous course, the content delivery was tuned to make each module more visually, pedagogically, and technologically interactive. The course content was delivered through 36 modules, in which each included a series of instructional videos, reading assignments, practical exercises, and online discussions that focus on a particular topic for each session. While the course delivery format is beyond the scope of this paper, it is useful to review the main component in order to understand how the online discussion blended with the other learning components in this course. The learning model in this course included four main components: 1) Study, 2) Practice, 3) Interact, and 4) Assess. Figure 1 illustrates the flow of the learning model.

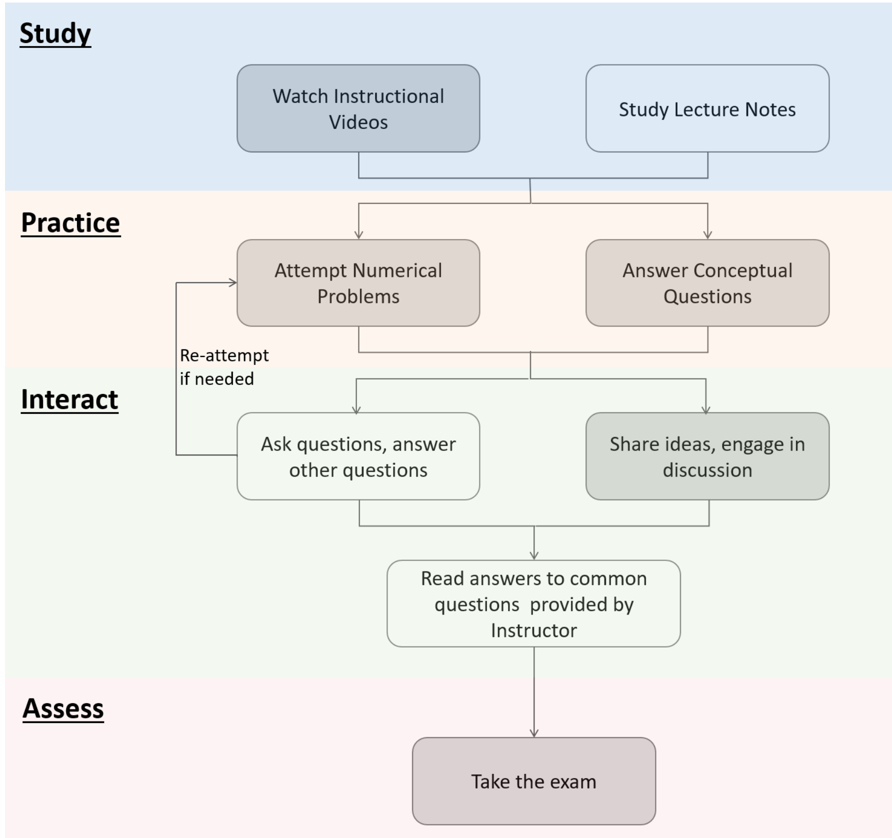

Figure 1- Learning components in the online asynchronous course (activities identified with darker background are mandatory, others are optional)

1- Study) Each course module typically started with a series of short instructional videos to establish the theoretical framework, followed by worked out examples to demonstrate the practical implementations. Traditional in-person lectures usually last an hour, but the instructional videos were intentionally short (average ~ 7 min), having been adapted to suit students' relatively shorter attention spans while watching educational videos online. To promote problem solving skills and higher level thinking, students were required to attempt several practice problems after watching the instructional videos. Zhang et. al. [14] reported that students who used interactive video content showed 20-30% higher achievement of learning outcomes in post-gain tests, compared to students who did not use video, or used video without interaction and reflection. This aligns with the observations of this study which indicated that the diversified responsiveness and interactivity of learning tools are beneficial for engaging students in the online environment.

2- Practice) The post-video practice problems used in this study consisted of both short conceptual questions that focused on certain misconceptions, as well as long calculation-intensive questions that required several steps to achieve the answers. Most calculation intensive questions have interim steps to guide students through the process and allow them to check the calculations in each step while they are approaching the final answer.

3- Interact) To promote interaction, an online discussion component - providing access and engaging a diverse group of students located in different geographical locations and time zones - was developed and implemented. In many online discussion forums, students can post questions, answer each others' questions or share ideas and hints. The online discussion tools developed and implemented in this study allowed for additional control over student interaction to facilitate multimodal communication such that students could benefit from, and optimally initiate, dialogue. The developedo online discussion tool was a stand alone web application but it could be integrated with LMS.

4- Assess) Students' understanding of the subject matter were assessed through 8 midterms and a final exam as summative assessments. The online students had the option to choose their own pace of study and take the midterm exams anytime after finishing the associated course modules. The online exams were proctored automatically using a campus approved remote proctoring service that was incorporated to Canvas as the course Learning Management System (LMS). The exam questions were randomly pulled from a pool of questions that consisted of various questions on the same topic and of the same difficulty level. Given the large number of questions in the pool and the use of algorithmically generated questions with random seed parameters, cheating by sharing the questions was not a concern during the semester.

This paper focuses on the online discussion introduced previously, and its implementation and interaction with other learning components. The online discussion served as an engagement tool with the purpose of initiating a multimodal communication hub for students to share ideas and ask and answer questions. There were various discussion opportunities as illustrated in the learning model flowchart. Activities identified with the dark color were mandatory, while the light color stands for optional activities. The mandatory online discussions were necessary to help the instructor prepare an answer to common questions to ensure students received the right feedback. As illustrated in the learning model flowchart (Figure 1), students were instructed to attempt the questions then post their questions or share their ideas on how to approach the problem. Following are the main implementations of online discussion in the designed online asynchronous course.

Discussion on conceptual topics: After watching the instructional videos, students were required to answer both conceptual and numerical questions related to the topic covered and to reflect on what they had learned on the videos. Despite their simple logic, some conceptual questions could be quite challenging specifically for novice learners who are just getting introduced to the topic. During the in-person class, instructors typically design active learning activities such as think-pair-share or other forms of activities to encourage students to share their ideas, learn from each other, and deepen their understanding. In order to compensate for such face-to-face interaction in the online medium, students were instructed to post their answers to questions, then read other responses to see how their peers answered the same questions. Students were also instructed to comment on the responses, provide feedback, suggest corrections if they caught any mistakes, and review the other students' perspectives. Participation in this discussion activity was required, and students were assigned grades based on their participation. Students could also upvote responses to support good ideas and answers. Bonus points were given to top responses to promote proper discussion and cultivate an informal, friendly, and productive environment. Examples of online discussion on conceptual topics are shown in Figure 2.

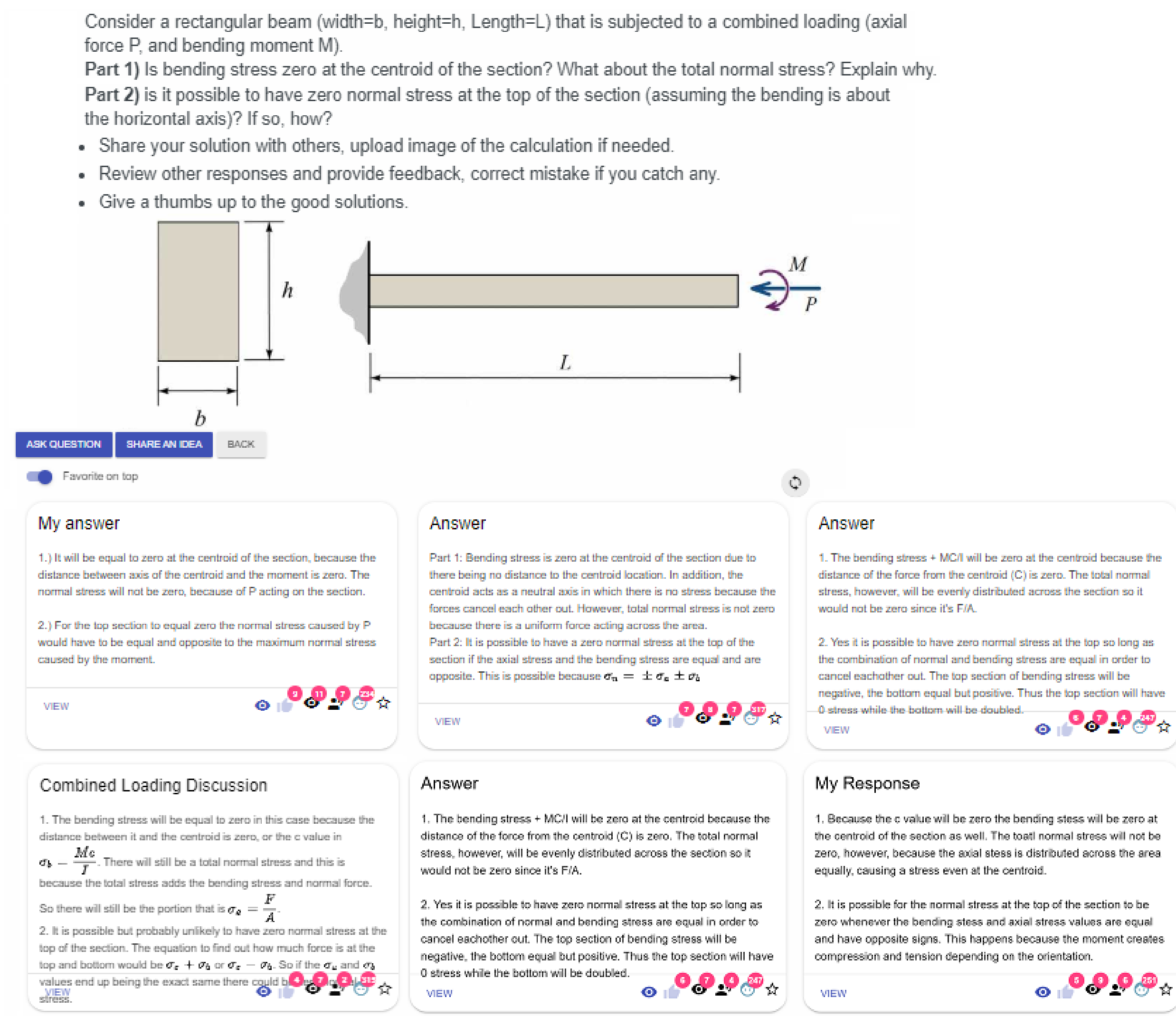

Figure 2. Example of online discussion on conceptual topics

Question specific discussion: The algorithmically generated practice problems provided students with the same questions in each activity, but each question had a unique set of randomly generated parameters, resulting in different final answers that prevented students from simply sharing the final answer. However, students were encouraged to exchange ideas on how to approach the problem and ask questions about the topics they found challenging. The discussion associated with practice problems was optional, but students could receive bonus points by sharing insightful ideas, answering questions or even asking questions that would lead to a better understanding of the topic. Students could attempt each problem up to 5 times without penalty. In every attempt, the seed parameters were randomly re-generated, so that they needed to focus on the algorithm of solving the problems, instead of solving for a certain set of parameters. One feature that differentiates the developed online discussion platform from the LMS built-in discussion forum is the ability to discuss a problem directly below it, thus allowing for easy access to the discussion without extra navigation between different course pages. The discussion is hidden by default, but it can be opened by students as desired. An example of a practice problem and the associated discussion are shown in Figure 3.

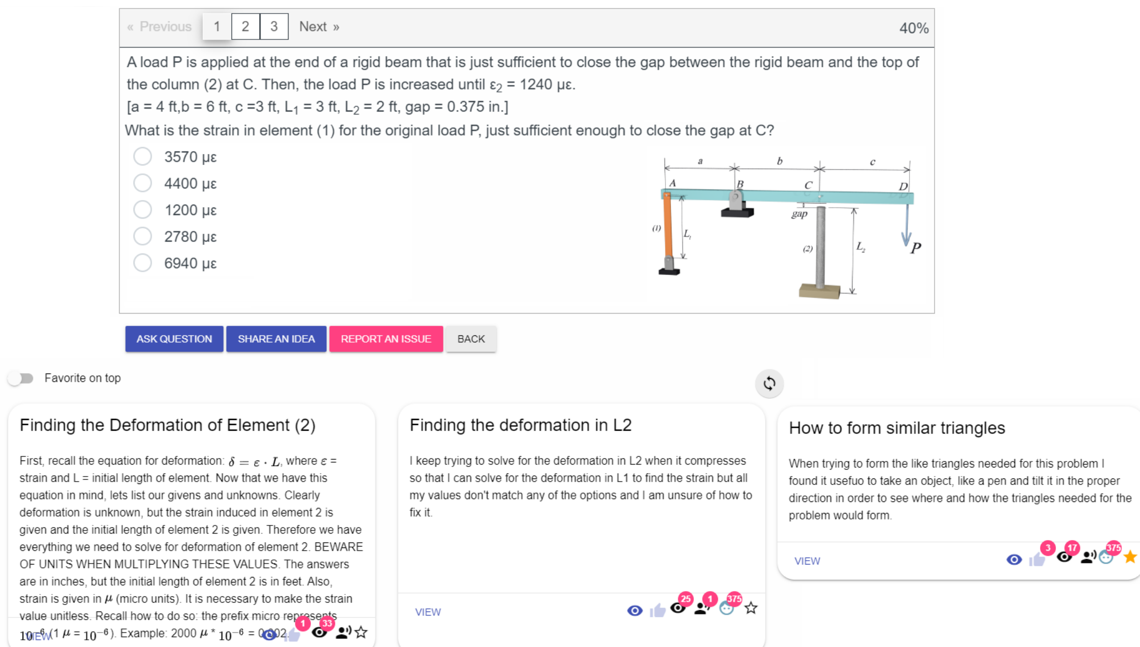

Figure 3. Example of online discussion on algorithmically generated practice problems

Sharing solutions to challenging problems: Certain questions could be challenging for students, and sometimes students became stuck on certain steps when attempting a problem. In face-to-face classes, students have more opportunities to seek help and interact with their instructor and peers either during the class meeting or outside of class. To account for this in the online section, another approach was implemented for student engagement via online discussion. This approach included the sharing of solutions to challenging problems. In this required activity, students were given a certain question that was found to be challenging based on students' responses in previous semesters. All students shared their worked out solution through the online discussion platform. Similar to the conceptual questions, students could upvote good solutions and the top solutions selected by students received additional bonus points. The difference between this activity and the discussion associated with the algorithmically generated practice problems is that in this activity, all students were working on the same set of problem parameters; thus, all steps and answers were the same so students could compare their solution with others and learn from possible mistakes. A sample of this discussion is shown in Figure 4.

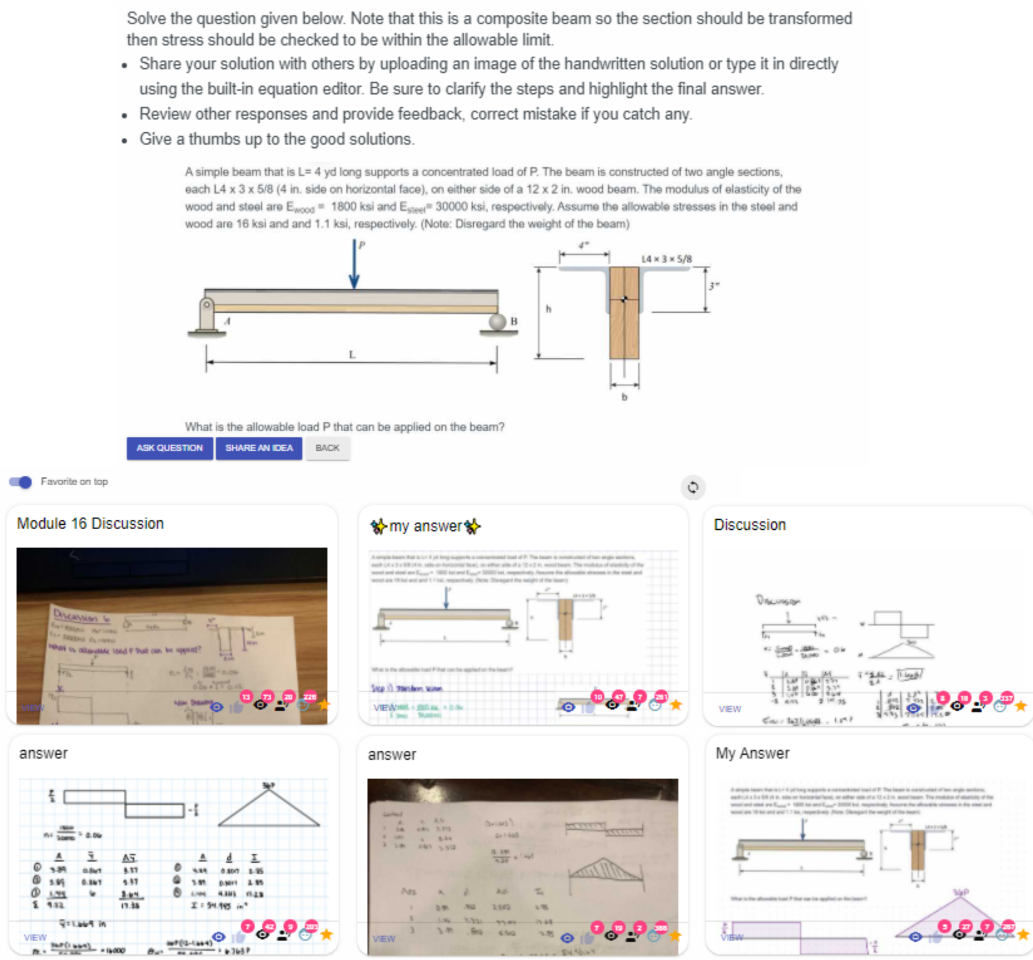

Figure 4. Example of online discussion bys sharing solutions to challenging problems

Performance in the online class versus in-person class: As noted before, our goal was to tune the online delivery format in a way that led to the same learning outcomes as in-person sections and preserved the desirable characteristics of the face-to-face courses. The learning outcomes can be defined as the change that occurs in students' knowledge/ability/skills after receiving a learning experience. While an accurate measurement of students' learning outcomes may be controversial, their performance in the summative assessments is an indicator of their level of understanding of the subject matter and their ability to implement the knowledge, and, as such, reflects the achievement of learning outcomes. The performance of students in three midterm exams were analyzed and compared with the performance of the in-person class in the same assessments (See Figure 5). The sample sizes of the online class and in-person class were 159 and 24, respectively. The performance difference between the two classes in the first exam was 10.6% in favor of the in-person class, but the gap reduced to 3.4% and 3.6% on the second and third exams, respectively. This is partially attributed to the time students needed to become familiar with the learning tools available in the online asynchronous course, including the online discussion platform. This study is still ongoing, and data is still being collected for a thorough comparison of students' learning outcomes.

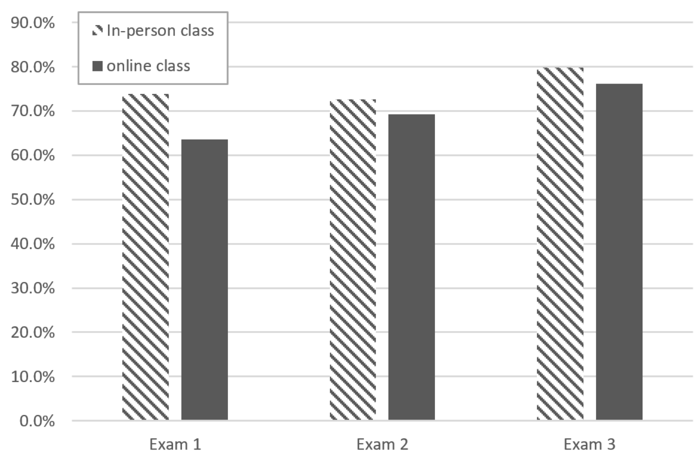

Figure 5. comparing students performance in the online class with the in-person class

Factors affecting students participation in the online discussion:

During this study we realized that there is a core group of students who actively participate in the discussion on a regular basis while another group of students remain silent with zero or very limited interaction when they are given the choice to participate. To investigate the factors affecting students participation we adopted a survey instrument developed by Shaw, Kim and Yoo [15] that is called Forum Participation Mediators Instrument (FPMI). The questionnaire of this survey is well suited to online discussions as related to the context of this study. The survey could be used for examining the mediators that affect students' contribution in the online discussions; the tool could also be used for generating a profile of students' perceptions of the extent to which the online discussion is beneficial for their learning. The questionnaire was modified slightly for this study to examine student perception of satisfaction and explore alternative methods of help seeking. The survey was administered to 159 students and 120 students participated in the survey, which is equivalent to a 75% response rate. The survey was conducted online and the options were shuffled to eliminate the effect of orders on students' responses.

Mediators of participation: It was found that incentive bonus credit dominated as a contributing influence for students participation, even if the offered bonus credit was limited. The total bonus points given for discussion participation was less than 5% of the total course grade, but it was still a motivating factor for many students. Having a question that they could not find the answer to or considering that other students might have the same questions as they do were the other factors contributing to participation that were chosen by more than 50% of students. The least motivating factor was “enjoying the course ideas online”. On the other hand, the only inhibiting factor selected by more than half of participants was not knowing how to answer other students’ questions. The sufficiency of reading other questions and answers was another factor selected by 47% of students. The behaviour of reading the discussions without posting or engaging with the community is not necessarily considered negative for purposes of this study.

Satisfaction of the online discussion: Student satisfaction with the online discussion tool may be another factor which influences students’ participation in the discussion. The results of Question 3 in FPMI that are summarized in Table 1 were used for measuring students' satisfaction with the online discussion tool. The average rating of the n=100 online discussion satisfaction responses in this study was 3.33, exactly the same as the average reported by Shaw et.al in their study. One difference between this study and the study conducted by Shaw et. al is the sample size. The number of responses for this study was n=100 compared to n=38 in the Shaw et. al study. The FPMI survey results also indicated that the online discussion was the most frequently used help seeking option, followed by ”Working with a group partner”. Shaw et.al [17] also noticed that ”Working with a group partner” and “Asking friends who have taken the course” were mostly used by students, but the use of an online discussion forum ranked lower than most other help seeking alternatives, in their study. The higher acceptance and usage of the online discussion in this study could be attributed to the features of the developed discussion platform specifically designed to align with the other learning components of the particular course in the study. Another reason that could explain the relatively high student satisfaction is the instructor/TA contribution in the online discussion to guide the discussion and ensure all questions were answered properly.

Table 1- Students' satisfaction with the online discussion

Question 3- Describe how often the following statements are true. (Only answer if you ever posted a question)					
Response	Never	Rarely	Sometimes	Often	Always
My questions are answered quickly.	3	16	56	22	3
My questions are answered satisfactorily.	1	6	35	46	11
My questions are answered thoroughly.	4	9	44	35	7
I feel that I learn by asking/ answering /reading the questions in the online discussion.	12	10	32	32	15

Concluding remarks

During the pandemic, and most likely for some time after the pandemic, many learning and teaching activities must be done remotely. Despite the challenges that instructors and students face when teaching and learning in the online environment, utilizing emerging technologies and adapting new teaching activities to foster an interactive learning environment online offers promising opportunities. Institutes play a crucial role in supporting faculty and students in meeting their objectives of transitioning to online teaching. Instructors and students, without proper training, face tremendous challenges in adapting to the new learning technologies in the online learning space. The online discussion tool presented and discussed in this paper is an example of successful application of a technology-oriented learning tool to facilitate learning for remote students. The preliminary measurements of the learning outcomes indicated the effectiveness of using such educational tools to close the learning gap between online and in-person classes. The survey conducted to study the mediators that both contribute to and inhibit students' participation in the online discussion tool revealed that the main inhibiting factor was not knowing how to ask the right question or how to answer someone else's questions. Also, the sufficiency of lurking (reading discussions without engagement) prevented some students from being active in the community. However, students who visualize the benefits, engage more readily in the online discussion. It should be noted that this willingness to engage in the community does not come without hesitation and resistance from students. It is also worth noting that the online discussion is generally rewarding for students who are more “verbally gifted” in written expression and may create advantages for certain groups of students over another one specifically those whom English is not their first language. Verbal communication is an essential skill for engineers and the impact of the online discussion on developing communication skills could be studied in the future research. The strategies and tools discussed in this study could be inspiring for instructors as to how they may repurpose the available resources and learning tools to maximize their instructional practice. While the approach presented in this study is focused on using a specific discussion tool, the presented approach can be implemented for other online courses regardless of which LMS is adopted.

References

[1] Chang, S., Kuo, A.C. (2021) Indulging interactivity: a learning management system as a facilitative boundary object. SN Soc Sci 1, 62 . doi.org/10.1007/s43545-021-00069-x

[2] Prince, M., (2004), Does Active Learning Work? A Review of the Research. Journal of Engineering Education, Vol. 93, No. 3, pp. 223-231

[3] Reed, B. (2018). Active Learning Success by Partnering Across the Institution. Proceedings

ACM SIGUCCS User Services Conference, pp. 69. doi:10.1145/3235715.3235718

[4] Kebritchi, M., Lipschuetz, A., (2017) Issues and challenges for teaching successful online courses in higher education : A literature review, J. Educ. Technol. Syst., vol. 46, no. 1, pp. 4–29.

[5] O'Hara, S., Pritchard, R., I'm teaching what?! Preparing university faculty for online instruction," J. Educ. Res. Pract., vol. 2, no. 1, pp. 42–53, 2012.

[6] Politis, J., Politis, D., "The relationship between an online synchronous learning environment and knowledge acquisition skills and traits: The blackboard collaborate experience," Electron. J. e-Learning, vol. 14, no. 3, pp. 196–222, 2016.

[7] Ishii K., Lyons M.M., Carr S.A. (2019) Revisiting media richness theory for today and future. Hum Behav Emerg Technol 1:124–131. https://doi.org/10.1002/hbe2.138

[8] Kenzig M.J.(2015) Lost in translation: adapting a face-to-face course into an online learning experience. Health Promot Pract 16(5):625–628. https://doi.org/10.1177/1524839915588295

[9] Fentiman, A., Siverling, E.A., Perez, R.S., Streveler, R.A., Loui, M., & Douglas, K. (2019). Putting Discussion-Based Engineering Education Courses Online. Proceedings of the 2019 American Society for Engineering Education Annual Conference and Exposition, Tampa, Fla., June 15-19

[10] Beebe, R., Vonderwell, S. , and Boboc, M. , (2009), Emerging patterns in transferring assessment practices from F2f to online environments, Electron. J. e-Lerning, vol. 8, no. 1, pp. 1–12.

[11] Schmidt, J., Libre, N.A., (2020) Implementation and Evaluation of Active Learning Techniques: Adaptable Activities for A Variety of Engineering Courses, Proceedings of the 127th ASEE Annual Conference and Exposition, Virtual conference, Virtual Online . 10.18260/1-2--34766, June 21 - 24, 2020

[12] Wagner E.D. (1994) In support of a functional definition of interaction. Am J Distance Educ 8(2):6–26

[13] Bickle, M. C., and Rucker,R., "Student-to-student interaction: Humanizing the online classroom using technology and group assignments," Q. Rev. Distance Educ., vol. 19, no. 1, pp. 1–11, 2018.

[14] Zhang D, Zhou L, Briggs RO, Nunamaker JF (2006) Instructional video in e-learning: assessing the impact of interactive video on learning effectiveness. Inf Manag 43(1):15–27

[15] Shaw, E., Kim, J., & Yoo, J. (2014). Mediators of participation in online discussions. Proceedings of the 2014 American Society of Engineering Education Annual Conference. Indianapolis, June 15-18