

## **WIP: Conversion of a Biotransport Course From Face-to-Face to Online**

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### Introduction & Motivation

Seniors at Texas A&M University enroll in BMEN 462: Mass & Energy Transport in Biosystems, a core, math intensive course. Upon successful completion of this course, students are able to mathematically define, describe, solve, and analyze general biotransport problems and develop transport models and approaches to contemporary biomedical problems and critically evaluate the solutions. The course design consists of eight content modules covering transport over cellular to whole body length scales. Traditionally the course is taught face-to-face (F2F) using a blended approach of lectures and collaborative problem-based learning (PBL) sessions. Two perturbations required the F2F teaching to convert to online delivery: (a) the response to the 2020 COVID-19 pandemic and (b) the department's desire to begin offering the course in summer semesters. The conversion of a traditional F2F course to online instruction possesses challenges to ensure mastery of learning outcomes are not jeopardized. Challenges include maintaining engagement, enabling interaction between students, teaching math-intensive material virtually while preventing Zoom fatigue, and maintaining active learning strategies. To address these challenges a novel initiative was developed to convert a traditionally-taught course to its final form to a blended course consisting of asynchronous mini-lectures using pre-recorded video, synchronous muddiest points (MP) forums, synchronous collaborative PBL sessions, and both asynchronous and synchronous exam components.

### Conversion Initiative

Course delivery modes over five semesters ('19-'21) included F2F, online, and hybrid. "Online" are remote or web-based courses where class meetings and exams are delivered synchronously or asynchronously online and all necessary class materials are submitted online. Fall '19 and 53% of the spring '20 semesters were taught F2F. Summer '20, fall '20, and 33% of spring '20 semesters were taught online. The spring '21 semester was taught F2F with a remote option – students had the option to attend class either in-person or remotely. Summer courses are self-directed web-based courses possessing asynchronous class and minimal instructor interaction.

**Lectures:** Fall '19 and 53% of spring '20 semesters consisted of traditional lectures. The lectures for the remainder of spring '20 through spring '21 semesters were converted to asynchronous delivery of 32 pre-recorded videos (2-5 videos/topic, average of 14 min/video). Students were provided slide decks of material discussed in the narrated videos. In addition, students completed asynchronous, randomized video quizzes to facilitate interaction with the material before class and to ensure they remained engaged. For fall '20 and spring '21 semesters, synchronous class "lecture" time was reserved for collaborative PBL and MP discussion forums. The latter consisted of the instructor addressing material students found to be the most difficult or confusing. Students were required to place their MP in a discussion board prior to class to identify common points of confusion and to facilitate interaction with the material before class.

**Collaborative PBL:** F2F, collaborative PBL activities consisted of student groups (4-5 students/group) developing solutions to 35 biotransport problems throughout the semester. Students actively dialogued and solved problems, whereas the instructor roamed the classroom to

facilitate problem solving. At the end of the class the instructor reviewed overall concepts students struggled with. For the abridged portion of spring '20 through spring '21 semesters, the collaborative PBL environment was converted to online. The learning experience consisted of the same student group size and activities except students were placed in pre-assigned Zoom breakout rooms to work together. Zoom video was required to be “on” and students were given permission to share screens with one another. The instructor randomly joined breakout rooms or joined rooms when a “request for help” notification appeared. Randomly joining the breakout rooms had the benefit of holding students accountable to stay engaged. Towards the end of class, the professor brought everyone out of breakout rooms for group discussion. Students attending the self-directed web-based summer '20 semester were still required to synchronously participate in collaborative PBL, but without the presence of the instructor. An online discussion board permitted the instructor to interact with questions asynchronously.

**Assessments:** Formative assessment consisted of asynchronous homework for all semesters. Summative assessment consisted of four closed notes/book exams, involving objective concept questions (part A) and problems to solve (part B). For all semesters, part A was deployed and completed asynchronously. Part B was completed synchronously during a scheduled class, deployed via handout for F2F class or via PDF for online class. Moreover, part B was live proctored by the instructor physically (F2F) or by Zoom with a two-device option (online). Summer courses are intended to be self-directed, so all exams were asynchronous.

**Analysis:** A total of 294 students are assessed over five semesters. Average class grades and grade distributions are statistically compared using ANOVA and Z test, respectively. Moreover, a 15-question survey was used to evaluate PBL through a five-level Likert scale. Selected student comments from end-of-semester course surveys are included when informative. Finally, qualitative instructor reflections are presented.

## **Preliminary Results and Reflections**

**Course Grades:** Grades were not curved in any semester and the type and level of formative and summative assessments were equivalent, thus the mean average class grades offer direct comparison of mastery of learning outcomes assessed. There was no statistical difference between the final grades ( $p=0.2$ ; average 91.3) or the grade distributions ( $z\leq 1.6$ ; 70% A, 27% B, 3.1% C) among any of the semesters. That is, there was no difference between F2F and online semesters. This agrees with several meta-analyses that demonstrate there is generally no difference in student performance of F2F and online instruction [1, 2].

**Lectures:** The combination of asynchronous video and synchronous MP discussion forums “flips” the traditional lecture-based classroom [3-5]. Students responded positively to the asynchronous videos indicating: “I really enjoyed watching the lectures on my own so I could pause the video or rewind if I missed something” and “At first I was really skeptical of the flipped approach but you really made it work for this class. I liked being able to watch the videos on my own time and pause/replay/etc. when I needed to.”

**MP Forums:** The MP forums is a value-added change moving from F2F to online delivery from the instructor’s perspective. Synchronous class time was spent on addressing content that students were struggling with rather than presenting basic information. Students likewise enjoyed spending valuable class time addressing their questions, indicating: “The [MP] lectures were

extremely beneficial in helping me learn how all of the notes for a certain chapter fit together. They also helped solidify concepts that I didn't fully understand.”

***Collaborative PBL:*** It was essential to maintain the collaborative PBL during the conversion from F2F to online due to its effectiveness as an active learning modality [6-8]. The F2F group experience was replicated in the online group experience based on student feedback and course survey evidence. There was no difference in the PBL survey results for all 15 questions across all semesters (data not shown). That is, students, regardless of the course delivery modality, found that PBL increased their confidence to solve problems, helped them think critically and apply theory to practice, and enhanced learning course material. In addition, student feedback was equivalent across all semesters: “Solving problems in groups was very useful for learning how to apply what we covered in lectures;” “The group work designated during class allowed for self-paced and directly applicable learning. It allowed for students to collaborate and ask for help if needed;” and “Solving the problem sets in class with our groups really helped. Especially when the professor was right there to solve our problems.”

***Homework and Exams:*** There was no difference in employment of homework or part A of exams over the five semesters. It was easier to proctor part B in a F2F classroom rather than in an online classroom. In the F2F class, students merely turned in a hardcopy of their worked-out solutions. For the online class, students took pictures of their solutions, converted and collated them into a single PDF file, and uploaded the PDF to the LMS within a 5-minute window. This process stressed students who were fearful of upload issues. Despite the added stress, students performed equivalently on the exams regardless of the course delivery mode (data not shown).

***Engagement:*** Qualitatively, there was no observed difference in the use of instructor office hours or email communication with teaching delivery. A major difference between the F2F and online delivery is the amount of active engagement required by the instructor. Intentional efforts were made to engage the students online and create a sense of community that is realized in a F2F environment, including providing opportunity for social dialogue at the beginning of class, providing interactive polls about non-class related topics, sending 2-3 class announcements per week, and facilitating engagement and syncing with the course schedule through short video quizzes and MP discussion board posts. Students indicated, “Having those short quizzes based on the lecture videos made sure we were on track with the course...that was a good way of keeping students engaged.”

***Other Factors:*** Other online factors may exist that affect student engagement and learning that were not assessed in either an observational or experimental fashion, including, but not limited to, digital divide, not being able to observe the instructor’s body language, eye contact, and physical gestures, sense of isolation due to lack of interaction with peers, and limitations to having quiet study space [9, 10].

## **Conclusions and Future Work**

The conversion of a biotransport course from F2F to online delivery was successful and the learning outcomes were equally met. The elements in the final version of the course will be maintained for future semesters.

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