Effective Transfer of Meaningful Design of Active Instructional Tasks to Online Synchronous Format. Potential for Transitional and Post-Pandemic Instruction

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Abstract

An introductory pharmaceutics course was redesigned before the pandemic to integrate deep-learning active tasks. The primary objective of this research proposal was to analyze the design transfer for an online synchronous context and monitor its impact on students' performance, perceptions, and beliefs. We found that highly integrated active learning tasks effectively transferred to the online format. In addition, student performance, perceptions, and opinions were similar or slightly better when compared with the live form of the course.

Motivation and Objectives of the Study

The COVID-19 pandemic restrictions at the local university at the beginning of the Fall 2020 semester allowed the instructors to decide whether the course will be offered in mixed-attendance format with both in-class and online groups or fully synchronous online. At the same time, when the instructor provided mixed attendance, students could decide if they would use the live or online option for attendance. For the courses that offered live attendance options, the state-wide distancing strategies were implemented, and masks were required.

For this research study, the focus was an introductory pharmaceutics course (Pharmaceutics I) that was redesigned before the COVID-19 pandemic to integrate active tasks such as in-class instant feedback with a personal response system (clickers) as well as deep-learning strategies such as productive failure (Cernusca & Mallik, 2018) and concept mapping (Cernusca & Mallik, 2020). When faced, due to COVID-19 pandemic restriction, with the choice of a mixed-attendance or fully online option for the pharmaceutics course, the instructor worked with an instructional designer and decided to implement a fully synchronous online option to adequately transfer the benefits of the active learning strategies already built in the course design.

The primary objective of this study was to describe the impact of the design constraints and affordances specific to the local COVID-19 pandemic context on the nature of the course implementation and analyze the impact of the design transfer to online format on students' performance, perceptions, and beliefs.

Instructional Design Affordances and Constraints

Design in general, and instructional design as one of its subsets, is a complex, ill-structured, and context-driven problem-solving process (e.g., Jonassen, 2011). Therefore, as a first step in designing or redesigning an instructional process, is the analysis of the design constraints and affordances specific to the target context of the instruction (Larson & Lockee, 2014).

Design Constraints

The target Pharmaceutics I course was built, at the time of this study, on a heavy integration of the active learning tasks into the lectures that ranged from basic active learning tasks (e.g., clicker questions) to more extensive strategies such as productive failure and concept mapping. Before the course started, because of the COVID-19 pandemic distancing requirements (Figure 1), the instructor had the option to use a mixed-attendance option and split the class into two groups: one group came to the class and the other attending remotely through Zoom. Besides the issues related to ensuring an equitable split of the students for the two attendance groups, several instructional constraints associated with selecting the mixed-attendance option were found.

Figure 1
Typical COVID-19 Pandemic Classroom

First, the classroom designated for the course was not fitted with audio and video technology to seamlessly integrate distance students in the live classroom. Consequently, a mixed-audience option would not allow integrating the live and remote students during the discussions associated with the hands-on activities in the course. Moreover, even for the students in the classroom, the requirements of safe distancing combined with the use of masks would have been hardly conducive to teamwork. Second, with a class size of 62 students, the instructor decided that it would be very hard, if not impossible, to fully and effectively integrate the live and the remote groups during the class time, especially without any previous training and a very short time to prepare for this type of classroom setting.

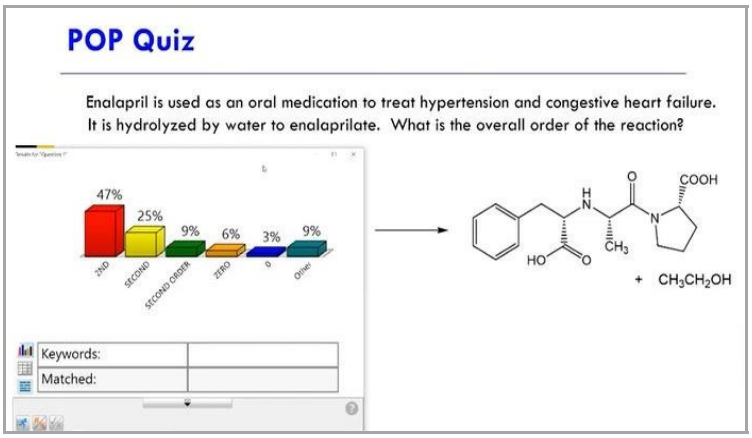
Design Affordances

On the other hand, when the existing course design and implementation were analyzed, several design affordances pointed toward the benefits of a fully online synchronous format of the course.

First, the lecture materials used in the course were already in a digital format, PowerPoint slides. Therefore, these instructional materials were readily transferable to an online synchronous form using online conferencing platforms such as Blackboard Collaborate Ultra or Zoom, both available to the instructor at the time of this study. Second, and even more critical for the overall effectiveness of the instructional process, active learning tasks were either already using a virtual tool or strategy (e.g., virtual clicker questions for on-time feedback) or directly transferable to online synchronous format (e.g., breakout rooms for group activities).

For example, active learning tasks already integrated into the instructional process, such as think-pair-share and productive failure, used virtual clickers in the live format and required no accommodations to transfer them online (see Figure 2).

Figure 2
Virtual Clicker Question Used During Lectures



Finally, the exams were set up in the live format of the course as open-book, and the only restriction imposed to the students during the exam was to not communicate with peers. This exam-related requirement could be easily enforced by requiring the students to use a second device that will allow live monitoring of their working space in the online conferencing environment used for the course.

Transfer of the Course to Online Synchronous Format

The analysis of the design barriers and affordances indicated that the synchronous online format of the course would fully use the identified design affordances and minimize the potential negative impact of design constraints. Also, a pre-course short survey sent by the instructor to the course cohort provided support for the above decision with most of the students either having a strong preference for online format of the course or no preference for a specific course format and only less than a fourth of the students indicating a strong preference for the live form of the course.

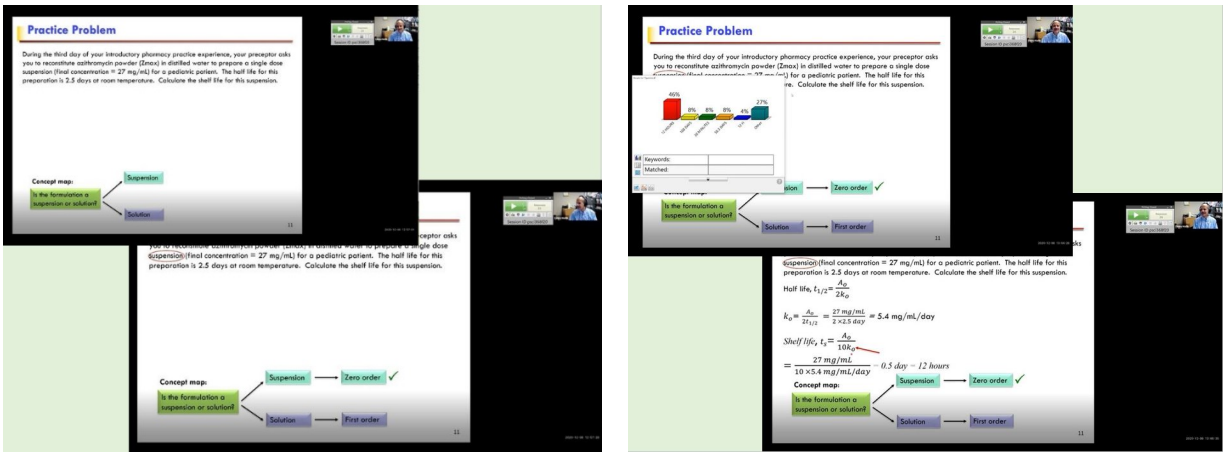
At the same time, the above analysis indicated that the instructor's preparedness for the online course administration was critical for the transition to the fully online format of the course. To ensure the effectiveness of the instructional process, the instructor set up a well-equipped office with a second monitor and HD webcam that allowed a smooth control of the course materials and a continuous monitoring of the chatroom. The online course was administered with Zoom® (https://zoom.us/) conferencing platform. All the online features required as part of the synchronous online course administration, from the chatroom to breakout rooms, and the use of the virtual clicker were pre-tested by the instructor with the help of an instructional designer and the teaching assistants assigned for this course. This process continued during the semester through short debriefing meetings between the instructor and the instructional designer and resulted in fine-tune adjustments to the online instructional process. Once the course started, the instructor kept his camera on and encouraged all students to keep their cameras on to get as close as possible to the live format of the course. On average, about 90% of the students complied to this request from the instructor and showed their cameras during the course (Figure 3).

Figure 3
Sample Lecture Zoom Wall-View

During the online synchronous lectures, the instructor successfully integrated active learning strategies such as clicker questions and concept mapping to support the problem-solving process and productive failure to provide additional instructional support for difficult problems. All these strategies were built and tested as part of live activities prior to the COVID-19 pandemic.

For example, Figure 4 shows a sequence of steps associated with a practice problem for which the instructor used a combination of concept mapping conceptual guiding strategy and clicker questions as support for the problem-solving process associated with worked examples used in the lecture.

Figure 4
Integration of Concept Maps and Virtual Clickers During Online Synchronous Lectures



Finally, for the team activities that ranged from the think-pair-share tasks associated with knowledge testing clicker questions to problem-solving, the instructor randomly split the class into small groups using the breakout room feature in Zoom. Then, when the problem-solving was the focus of the group activity, the instructor asked a representative from each group to type their answer in the chatroom and used the students' chatroom input to move to the next step in the instructional process.

In addition, at the beginning of the semester, the instructor decided to monitor the overall pandemic situation for one month and decide at that time, along with his students, if a switch to hybrid attendance would be preferred. However, when students were asked about the potential

change in the course format, they selected the fully online synchronous option for the entire semester.

Design Transfer Effectiveness: Research Methodology

The instructor worked with an instructional designer both before and during the COVID 19 pandemic to monitor the significant active learning instructional tasks implemented in this course to identify possible improvements in the course structure.

Research Design

We used a comparative exploratory quantitative research design for this study complemented with qualitative triangulation data from students' course evaluations. The analyzed dependent variables were students' course self-efficacy, perceived course difficulty, perceived impact of productive failure, the perceived impact of concept mapping on students' learning and student performance outcomes for two assessments significant for the major active learning tasks implemented in this course. The independent variable was the cohort and had two levels: pre-pandemic face-to-face instruction and CODIV-19 fully online synchronous instruction.

Data Collection

Every semester the instructor administered a prior knowledge survey to test the homogeneity of the cohorts. In addition, an exit survey that included believes and perception constructs adapted from the literature was administered online using Qualtrics during the last two weeks of the course. The exit survey included a beliefs construct, self-efficacy, adapted from Bham et al. (2011) and three perception constructs, one related to perceived course difficulty adapted from Kappelman (1995) and two related to the perceived impact of productive failure and respectively concept maps, adapted from Grasman et al. (2013). All constructs were evaluated on a 1-low to 9-high scale, and most of them showed a very strong internal reliability above the 0.70 benchmarks suggested in the literature, as follows: self-efficacy, Cronbach's Alpha=0.91; perceived difficulty, Cronbach's Alpha=0.62; the perceived impact of concept maps and respectively productive failure both with Cronbach's Alpha=0.97.

All students enrolled in the course were invited to participate in this study. Participation was voluntary, and there was no payment or grading reward for participating in this study. For the face-to-face group (Fall 2019) of the 75 students enrolled in the course, 74 (99%) completed the prior knowledge quiz and 56 (75%) completed the exit survey. For the online group (Fall 2020), of the 62 students enrolled in the course, 60 (97%) completed the prior knowledge quiz, and 36 (58%) fully completed the exit survey.

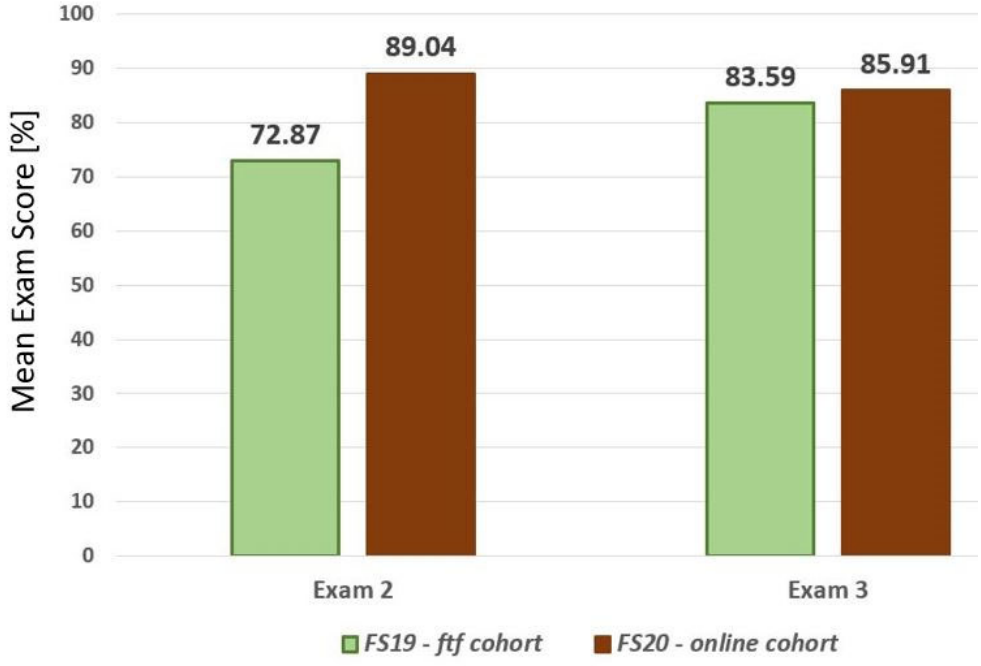
Data Analysis and Results

Data was analyzed using SPSS v27®. An independent sample t-test indicated that the exam mean score for the online cohort (38.33%) was slightly higher than for the pre-pandemic cohort (38.12%). However, there was no statistically significant difference between the mean scores of the two cohorts ($p = 0.93$). This finding showed that the two cohorts were homogeneous at the entry point in the course.

To analyze if the transfer of the target course to the online format was successful in the first stage, we examined students' perceptions of the major instructional strategies implemented in the course and the course as a whole. First, an independent sample t-test indicated that for the perceived impact of productive failure. At the same time, online students' mean score (6.61, on a scale of 1-low to 9-high) was lower than for the live cohort (6.95). However, the difference was not statistically significant ($p = 0.36$). Similarly, the mean score for the perceived impact of concept maps for the online cohort (6.59) was lower than for the live cohort (7.21), but the difference was not statistically significant ($p = 0.11$). Second, an independent-sample t-test indicated a statistically significant lower perception of online course difficulty, 4.94 compared to the pre-pandemic face-to-face format of the course, 5.96, $t(90) = 3.55$, $p < 0.01$.

In a second stage, we analyzed two factors related to student performance, epistemic beliefs, typically seen as a proxy for learners' future performance, and respectively student performance on the two assessments, second and third exams, that measured the impact of productive failure and concept mapping strategies. First, an independent-sample t-test showed that the mean scores for the online cohort (7.06, on a scale from 1-low to 9-high) were practically identical to the fact-to-face, pre-pandemic cohort (7.04), $p = 0.95$. Second, for the second and third exam that included assessment items that were the target of the two primary active learning strategies implemented to improve students' learning outcomes, concept mapping, and respectively productive failure, the average mean scores were higher for the online cohort when compared to the face-to-face, pre-pandemic cohort (Figure 5).

Figure 5
Mean Exam Scores for the Online and Face-to-Face Cohorts



While the online cohort had higher mean scores than the face-to-face, pre-pandemic cohort, an independent-samples t-test indicated a statistically significant difference for Exam 2, $t(129) = 9.84$, $p < 0.001$ but no statistically significant difference for Exam 3 ($p = 0.30$).

Finally, students' comments from the course evaluation report confirmed the effectiveness of the transfer of the course to the online format during the Fall 2020 semester. They ranged from focused short answers that recognized this effectiveness, "…thank you for easily adjusting class to zoom", to the ability of the instructor to make the course easy to engage in, "I enjoyed his class! He [the instructor] was easy to listen to and did very good at keeping us focused, which is very hard to do when a class is only online" and to the more detailed description of the benefits of this fully online format compared to the regular in-class format:

> Overall, I really enjoyed going to this class every day, even though I do not normally enjoy Zoom lectures because of how dry they tend to be. He [the instructor] was quite the opposite. He also was able to get at least 90% of the class to turn on their web cameras during the lecture, which was impressive.

Discussions and Further Research

The research results from the analysis of students' self-reported and assessment outcomes data indicated that highly integrated and targeted active learning tasks can be effectively transferred to an online synchronous format. The student perceptions, epistemic beliefs, and assessment performance were similar, slightly better, or statistically significantly better than the ones we found in the live, pre-pandemic format of the course. In addition, student input in the final course evaluations supported our findings from the quantitative analysis.

References

Cernusca, D. & Mallik, S. (2018). Making Failure Productive in an Active Learning Context. Improved Student Performance and Perceptions in a Pharmaceutics Chemistry Course. *Quarterly Review of Distance Education.* 19(2), 37-50.

Cernusca, D. & Mallik, S. (2020). Disrupting Students' Learning Micro-Culture in a Graduate Pharmaceutics Course: Perceived Impact of Deep Learning Strategies on Self-Efficacy. *2020 AECT Virtual International Convention, 43rd Annual AECT Proceedings*, Nov. 2-7, Virtual, Vol.1, 60-68.

Bham, G. H., Cernusca, D., Luna, R. & Manepalli, U.R.R. (2011). Longitudinal Evaluation of a GIS Laboratory in a Transportation Engineering Course, *Journal of Professional Issues in Engineering Education & Practice*, 137(4), 258-266.

Grasman, K., Cernusca, D. & Long, S. (2013). Student Perceptions of Online Resources as Predictors of Performance in a Hybrid Classroom: Exploratory Findings from a Large Engineering Economics Course. *Proceedings of the 120th ASEE Annual Conference & Exposition,* June 23-26, Atlanta: GA.

Jonassen, D. H. (2011). *Learning to Solve Problems. A Handbook for Designing Problem-Solving Learning Environments*. Routledge, Taylor & Francis Group.

Kappelman, L. (1995). Measuring User Involvement with Information Systems and with Their Development, *Journal of Computer Information Systems*, (Summer), XXV (4), 66-76.

Larson, M.B. & Lockee, B.B. (2014). *Streamlined ID. A Practical Guide to Instructional Design*. Routledge, Taylor & Francis Group.