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Learning to Learn – A Potential Educational Focus During and Post the COVID-19 Pandemic

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ABSTRACT

Challenges posed to the online classes during the COVID-19 epidemic, which prevented instant face-to-face communication and forced physical separation, were tentatively resolved by a teaching strategy shift to foster and improve student self-study skills. Class slides, teaching formats, as well as learning activities were redesigned and implemented accordingly. Midterm exam performance was comparable to that of a previous class. A class survey revealed students' acceptance of the new teaching arrangement, with enhanced skills and confidence in self-studying perceived by the students. Further research is needed to examine the efficacy of such changes for students' performance and skills acquisition.

Key words: online teaching, self-study skills, lecture-free teaching

INTRODUCTION

The remote teaching scenario caused by the COVID-19 epidemic posed two main challenges for teaching *General Chemistry for Engineers II* to a cohort of 196 freshmen engineering students at Sichuan University-Pittsburgh Institute. One challenge was the absence of face-to-face communication. Without eye contact, facial expressions, and quick verbal quizzes, it was difficult to decide the optimal pace of online lectures. Although online tools can provide instant feedback, they can also create barriers which might discourage students from class participation. The other perceived challenge was the lack of engagement due to the physical separation. Attendance in lectures and free riding with class team works could not be monitored.

While online tools and teaching methods can be explored to resolve such challenges, an alternative strategy is to teach students skills to learn by themselves. This alternative focus may require a systematic change including but not limited to course objectives, teaching/learning styles and activities, and assessments.

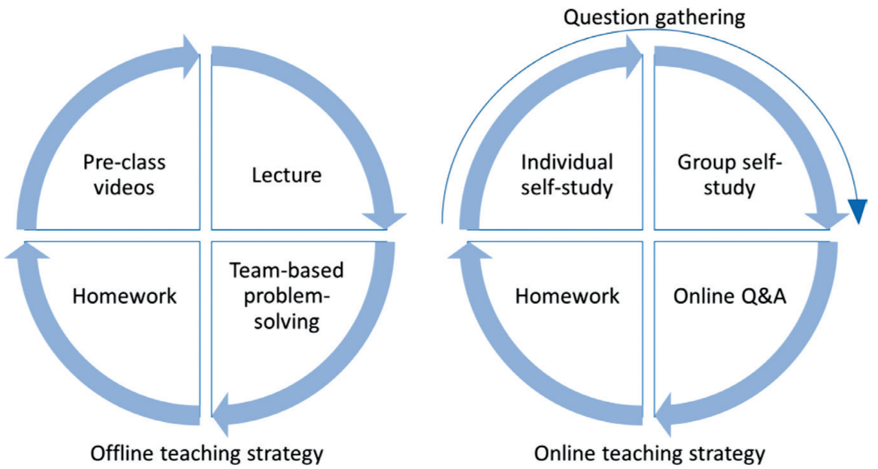

Figure 1. Teaching strategies offline (left) and online (right) for General Chemistry for Engineers II.

METHODS

As Figure 1 summarizes, the course teaching strategy was modified such that pre-class videos and lecture were replaced by individual study and online Q&A. The class started from students studying PowerPoint slides on their own laptops/smartphones (i.e., individual self-study), solving a problem set in teams (i.e., group self-study), and to attending a 40-minute online Q&A session (Via Blackboard see https://www.blackboard.com/) with the BigBlueButton function) where points of confusion and questions were gathered via an online survey (Via online teaching platform Ketangpai see https://www.ketangpai.com) during the two self-study sessions. During the survey, instructors (one professor and two undergraduate TAs) randomly messaged students via an instant message app (Via QQ see https://www.imqq.com/English1033.html) with questions to enhance learning activeness and check learning quality. The homework load and format were adjusted to allow for online submission.

To facilitate self-study, the slides were reorganized in both format and content as a replacement for the lecture. Texts, audios, and videos were added to provide better understanding. Questions and hints were built in as check points to ensure study quality (Figure 2). Content was more explicitly organized in the sequence of concepts/laws/problems, hypothesis/theories, validation experiments following the pedagogy of inductive teaching (Prince and Felder 2006) (Figure 2 b, c, and d).

The use of check points and the sequence in approaching new knowledge were explained and emphasized later on in the live Q&A session in the hope that students would benefit metacognitively from monitoring and evaluating self-study quality (Paris and Winograd 1990).

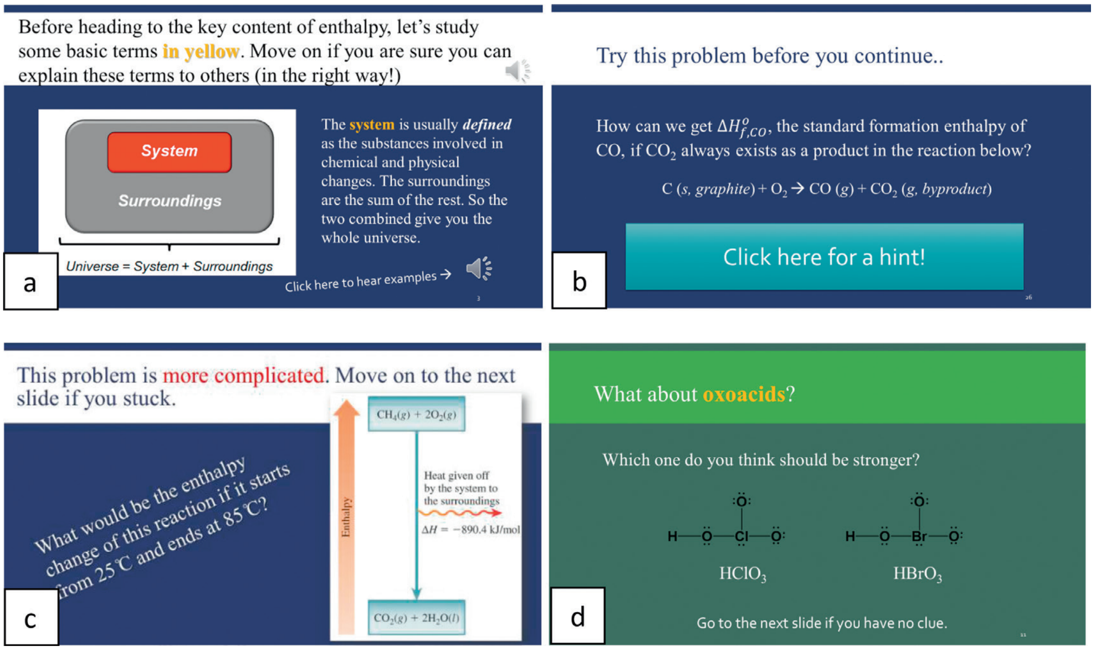

Figure 2. Example slides. New concepts are highlighted in yellow. Explainations, hints, and/or questions were given in text, audio, or video. Inductive teaching was conducted by posing questions before relevant contents/theories (b, c, and d).

The majority of labor in preparing self-directed learning materials went to redesigning slides. Up to 8 hours were spent for the first week as there were more tutorials and self-made videos. As semester progressed, slide preparation time decreased to 2-3 hours a week as templates and graphics were reused and videos from Khan Academy (see https://www.khanacademy.org) were employed.

PRELIMINARY RESULTS

The new teaching strategy was very well received by the students. Higher efficiency in self-study was claimed by some students. Given the freedom to disengage and then reengage with the slides without missing any content, which is easily experienced in live lectures, students could cross check information among study materials. Attendance at the live Q&A session reached almost 100% in the first few weeks and gradually decreased to around 60% at the semester's end. Statistics on the views of recorded sessions were unfortunately not available to testify students' claim of watching the recordings later on as they might have needed more time for group self-study.

Although each week fewer than 20 students responded to the Q& A survey, the questions raised were of high quality, overlapped slightly (with less overlap over time), and were occasionally outside the scope of the course. Student interviews revealed that questions were first asked around to peers and/or TAs for instant help. Only unsolved questions were entered to the survey by the "big guys", a nick name given to the top students. Such a study pattern, partly evident in Q4 and Q5 in Table 1, echoes previous studies that Asian students in the U.S. prefer asking help from students than from instructors (Raymond and Choon 2017) and only valuable questions should be asked to the instructors (Jin and Cortazzi 1998;Foster and Stapleton 2012).

EFFECTIVENESS

Midterm

The average score of the midterm at week 6 was 66.77% (n = 194, SD = 11.95), which was not lower than the average of 67.33% (n = 191, SD = 10.66) for a previous class on exact the same set of exam questions given in close-book. Further research is needed to evaluate students' real performance, since this exam was given online without proper proctoring, which might have led to high average scores, and was graded based on participation rather than accuracy in order to discourage cheating, which might have led to low average scores (i.e. some students only finished the multiple-choice questions).

Class Survey

At week 18, a voluntary class survey (n = 156, see Table 1) was conducted to evaluate changes on behavioral, agentic, cognitive, and emotional engagements (Reeve 2013) that students experienced this semester. In general, the increase in behavioral engagement in chemistry was largely driven by self-study (Q1–Q3). Not surprisingly students perceived no change in revealing knowledge mastery to the professor (Q6, Mean = 4.17 > 4, p = 0.107), since they sought more help from peers than from instructors (Q4, Mean = 5.08 > Q5, Mean = 4.33, p = 0.000).

Students reported gaining skills in learning new concepts/theories (Q10, Mean = 5.34) and solving more complicated problems (Q11, Mean = 4.95). Consistent emotional engagement was reported as they liked the new teaching format better (Q12, Mean = 4.65), were more interested in chemistry (Q13, Mean = 4.95), and expressed more confidence in self-studying (Q14, Mean = 5.17).

Pearson correlation coefficient shows positive correlation between every pair of questions (p_{max} = 0.003), as shown in Appendix 1. A high coefficient above 0.6 was seen between Q5 and Q6 (0.661, p = 0.000), Q6 and Q11 (0.608, p = 0.000), and Q10 and Q 11 (0.695, p = 0.000). It makes sense that using more office hours would lead to a better reveal of knowledge mastery to the professor

Table 1. Student perception of the self-study oriented teaching arrangement. Levels: 1 – strongly disagree; 2 – disagree; 3 – slightly disagree; 4 – neither disagree or agree; 5 – slightly agree; 6 – agree; 7 – strongly agree

To what degree do you agree with the following statements?	Mean	SD.
Behavioral Engagement		
Q1 [Comparing to last term, I spend more time in studying chemistry this term.]	4.94	1.53
Q2 [Comparing to last term, I participate more in group discussion.]	4.79	1.91
Q3 [Comparing to last term, I spend more time in self-studying.]	6.13	1.24
Agentic Engagement		
Q4 [Comparing to last term, I more often seek help from other students.]	5.08	1.80
Q5 [Comparing to last term, I use more office hours, including asking questions to TAs, professor, or via Ketangpai.]	4.33	1.81
Q6 [Comparing to last term, I let the professor know better what I know or don't.]	4.17	1.67
Q7 [Comparing to last term, I made more effort in adjusting my learning habit.]	5.21	1.51
Cognitive Engagement		
Q8 [The questions on the slides are more complicated than those asked by the professor in lectures last semester.]	4.92	1.43
Q9 [Comparing to last term, I tried to make more connections between the content in each slide and my previous knowledge or experiences.]	5.47	1.33
Q10 [Comparing to last term, I now have a better idea on how to learn new concepts and theories.]	5.34	1.35
Q11 [Comparing to last term, I am better in solving complicated problems, especially those without examples in the textbook.]	4.95	1.50
Emotional Engagement		
Q12 [Overall, I like the new online teaching format better.]	4.65	1.76
Q13 [I become more interested in Chemistry.]	4.95	1.46
Q14 [I feel more confident in self-studying.]	5.17	1.46

(Q5 and Q6), the latter of which is noteworthily highly correlated with gaining skills in solving more complicated problems (Q6 and Q11). The skill gain in solving complicated problems is also highly correlated with students' increased skills in learning new concepts and theories (Q10 and Q11).

It is noteworthy that group study might be better than individual study to elevate students' agentic, cognitive, and emotional engagement in improving their self-studying skills. As seen in table 2 (partially adapted from Appendix 1), the Pearson coefficients between Q2 and Q4-Q14 are higher than those between Q3 and Q4-Q14 with the exceptions of Q7, Q8, and Q14. Students spent more time in group study in general reported more interactions with the TAs and instructors, more gain in self-study skills, and more likeness towards chemistry and the new form of teaching. While students participated more in group study perceived less difficult questions on the slides, they felt less confident in self-studying.

A similar trend is also seen between students using more office hours (Q5) and those who sought more help from peers (Q4). Students using more office hours perceived more gain in self-study skills

Table 2. Comparison between the Pearson correlation coefficients (with p value) of Q2 and Q3 to the rest questions.

Pearson correlation coefficient (p value)	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14
Q2	0.558 (0.000)	0.584 (0.000)	0.568 (0.000)	0.431 (0.000)	0.274 (0.001)	0.433 (0.000)	0.504 (0.000)	0.440 (0.000)	0.544 (0.000)	0.530 (0.000)	0.332 (0.000)
Q3	0.359 (0.000)	0.236 (0.003)	0.257 (0.001)	0.437 (0.000)	0.333 (0.000)	0.341 (0.000)	0.396 (0.000)	0.263 (0.001)	0.263 (0.001)	0.249 (0.002)	0.380 (0.000)
Q4							0.426 (0.000)	0.362 (0.000)	0.369 (0.000)	0.275 (0.001)	0.290 (0.000)
Q5							0.487 (0.000)	0.478 (0.000)	0.552 (0.000)	0.515 (0.000)	0.414 (0.000)

(Q10 and Q11) and confidence (Q14). They also liked the online teaching more (Q12) and became more interested in chemistry (Q13).

NEXT STEPS

While positive results are generated, questions are also raised in this paper echoing those asked previously, including: *Is asynchronous teaching/learning a better solution* (Russell 1999)? *To what degree is lecture still necessary* (Wood 2009)?, and *Should learning to learn become a new focus in teaching* (Brown, Campione, and Day 1981)?

To address these questions, the efficacy of this new teaching approach should be carefully examined. A series of teaching materials and activities may have to be changed, including but not limited to the structure and presentation of textbook, reading assignment and slides, the manner of instruction (inductive vs. deductive), class activities, assignments, and assessments. Such changes should be aligned to maximize not only the efficacy of teaching self-learning skills but other important skills such as communication, critical thinking, and problem solving.

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APPENDIX

PEARSON CORRELATION COEFFICIENTS AND THEIR P VALUES BETWEEN QUESTIONS.

Pearson correlation coefficient (p value)	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14
Q1	0.589 (0.000)	0.334 (0.000)	0.375 (0.000)	0.528 (0.000)	0.485 (0.000)	0.531 (0.000)	0.356 (0.000)	0.526 (0.000)	0.423 (0.000)	0.370 (0.000)	0.523 (0.000)	0.404 (0.000)	0.272 (0.001)
Q2		0.235 (0.003)	0.558 (0.000)	0.584 (0.000)	0.568 (0.000)	0.431 (0.000)	0.274 (0.001)	0.433 (0.000)	0.504 (0.000)	0.440 (0.000)	0.544 (0.000)	0.530 (0.000)	0.332 (0.000)
Q3			0.359 (0.000)	0.236 (0.003)	0.257 (0.001)	0.437 (0.000)	0.333 (0.000)	0.341 (0.000)	0.396 (0.000)	0.263 (0.001)	0.263 (0.001)	0.249 (0.002)	0.380 (0.000)
Q4				0.393 (0.000)	0.500 (0.000)	0.258 (0.001)	0.420 (0.000)	0.290 (0.000)	0.426 (0.000)	0.362 (0.000)	0.369 (0.000)	0.275 (0.001)	0.290 (0.000)
Q5					0.661 (0.000)	0.515 (0.000)	0.307 (0.000)	0.363 (0.000)	0.487 (0.000)	0.478 (0.000)	0.552 (0.000)	0.515 (0.000)	0.414 (0.000)
Q6						0.525 (0.000)	0.445 (0.000)	0.429 (0.000)	0.590 (0.000)	0.608 (0.000)	0.555 (0.000)	0.444 (0.000)	0.434 (0.000)
Q7							0.362 (0.000)	0.572 (0.000)	0.530 (0.000)	0.467 (0.000)	0.467 (0.000)	0.404 (0.000)	0.440 (0.000)
Q8								0.458 (0.000)	0.412 (0.000)	0.408 (0.000)	0.293 (0.000)	0.287 (0.000)	0.268 (0.001)
Q9									0.552 (0.000)	0.499 (0.000)	0.414 (0.000)	0.388 (0.000)	0.270 (0.001)
Q10										0.695 (0.000)	0.508 (0.000)	0.477 (0.000)	0.518 (0.000)
Q11											0.470 (0.000)	0.494 (0.000)	0.465 (0.000)
Q12												0.568 (0.000)	0.519 (0.000)
Q13													0.488 (0.000)
Q14													1