HOW WE TEACH | Classroom and Laboratory Research Projects

A flipped classroom method based on a small private online course in physiology

Xiao-Min Zhang,1 Jian-Yun Yu,2 Yuan Yang,1 Cui-Ping Feng,1 Jing Lyu,1 and Shi-Lian Xu1
1Department of Physiology, School of Basic Medicine, Kunming Medical University, Kunming, P.R. China; and 2Teaching Quality Monitoring and Evaluation Center, Kunming Medical University, Kunming, P.R. China

Submitted 30 July 2018; accepted in final form 11 June 2019

Zhang XM, Yu JY, Yang Y, Feng CP, Lyu J, Xu SL. A flipped classroom method based on a small private online course in physiology. Adv Physiol Educ 43: 345–349, 2019; doi:10.1152/advan.00143.2018.—A small private online course (SPOC) supports blended learning on a small scale, enabling students to have a more comprehensive and deeper learning experience. It also provides instructors with a flexible and feasible model to better understand the students’ learning needs and to supervise students’ learning behaviors. In this study, we adopted SPOC flipped classroom blended teaching in the physiology course for clinical undergraduate students of Kunming Medical University. Compared with the control group [lecture-based learning (LBL)], the SPOC flipped classroom method significantly increased the scores of students in the preclass test (65.13 ± 12.45 vs. 53.46 ± 8.09, SPOC vs. LBL) and postclass test (80.43 ± 14.29 vs. 69.01 ± 12.81, SPOC vs. LBL), which is induced by students’ increased interest in self-learning. More importantly, the significant difference between the preclass scores of the two groups suggested that the video lecture-based preview is more effective than the textbook-based preview. The study indicated that the SPOC flipped classroom was effective in enhancing the examination scores of students, reflecting an improved learning efficiency and a deeper understanding of the knowledge. In summary, the flipped classroom based on SPOC improves learning outcomes compared with LBL and has a wide application in the learning of basic medical courses.

flipped classroom; physiology; small private online course

INTRODUCTION

The emergence of the massive open online courses (MOOCs) in 2012 has led to the reform of online education (8). Over the last few years, many MOOCs have taught millions of students in virtual classrooms, changed learning techniques, and redefined traditional boundaries in university teaching (9). However, despite current opportunities, MOOC faces the challenge of integrating online courses with classroom teaching. Furthermore, the low engagement, high dropout, and the complexity of students’ background are also major problems. Professor Armando Fox at the University of California Berkeley first raised the idea of the small private online course (SPOC) to address these problems. He believed that SPOC should be an extension of MOOC, designed specifically for university students. By optimizing and modifying the original version on the MOOC platform, Fox created the SPOC “Advanced Software Engineering” for university students. This intervention resulted in a fourfold increase in the number of registrations (2). SPOC can overcome the limitation of MOOC and traditional lecture-based learning (LBL) (5). A study considered that the SPOC had a sustainable concept and created an environment suitable for learning, thus fitting with the need for social interactions in higher education (11).

Physiology is a core component of the medical curriculum (10) and is difficult for students to master (7). This study adopted the SPOC teaching method, targeting university students with a combination of the online video lecture and the offline flipped classroom. The study intended to explore the application of this blended learning in a physiology course with the purpose of acquiring an improved learning experience and to lay the foundation for the application of SPOC in basic medical education in universities.

MATERIALS AND METHODS

Study Participants

The participants are all second-year undergraduate students majoring in clinical medicine. The students enrolled in this major have passed the same national college entrance examination and have obtained comparable scores. Before this experiment, they attended the same courses during their first year of college; therefore, their basic knowledge level was similar. Furthermore, these participants are in the same grade and are of a similar age. There are six classes of students (~600 students) majoring in clinical medicine at Kunming Medical University within one grade. We randomly chose one class (115 students) as the experiment class, which received a flipped classroom based on SPOC for physiology, and another class (82 students) as the control class, which experienced LBL for the same course. These students experienced the same syllabus in physiology and other previously learned courses, and they had studied the basic medical courses for 1 yr. Both the experiment and control classes have the same teaching schedule.

Ethics

This study investigated the use of a flipped classroom method based on SPOC in a physiology course. To compare, we chose the LBL teaching mode for the control. Students in both classes were informed about the experimental design. Given that this experimental method was part of the regular teaching-learning activities of the students, ethical approval was not required, according to the policy of China.
Optimize learning content and record video lecture. We integrated the content according to the syllabus and recorded video lectures for each knowledge point. The video was designed following the principle of “simple and practical.” All videos were <10 min and were composed of four parts: concept introduction, concept explanation, classic examples, and knowledge summary. This allowed for systematic learning of every knowledge point.

Construct online learning platform. Providing an effective self-learning platform is paramount to enable effective self-learning. In this study, our online learning platform was built on the online course platform of Kunming Medical University. (The website is based on the online course platform of Kunming Medical University generated by Shanghai ZhiyouRuiXin Digital Technology Co., Ltd. The online course website is http://220.163.113.53/G2S/site/preview#/rich/v/118432?ref=’&currentoc=11545). On the website, students can find the syllabus, teaching plan, lecture notes, courseware, and video lectures. The aim was to provide a self-learning platform with abundant online learning materials and a clear knowledge structure for students.

Organize preclass tasks. The following were included in the preclass tasks. 1) The teaching plan was released 2–3 wk ahead of time by instructors. In the teaching plan, the students were informed of learning objectives and learning methods to enable effective self-learning and to avoid formalism. 2) Students were divided into groups, with 8–10 students in each group. According to the learning tasks issued by the instructors, students were to watch video lectures and PowerPoint presentations by themselves ahead of the class. The classroom lectures were replaced by video watching: 120 min of lectures were replaced with 3 videos and 85 PowerPoint slides. The students in the intervention group could arrange the learning progress, but the students in the control class practiced self-learning by solely relying on the textbook. The control and experiment groups covered the exact same content: urine generation and excretion. 3) Students in both control and experiment classes were required to complete a quiz (consisting of 10 items) related to their self-learning content before the class.

Carry out the classroom teaching. The SPOC-based flipped classroom is blended learning, combining online learning and classroom teaching. The students report in groups in the classroom teaching. Each group was randomly assigned a question, and one student was randomly assigned to explain and report the question. All of the students in the experiment class were in the same classroom, with two instructors guiding and grading. The instructors were only organizers and directors for learning: their roles were to guide students to find answers to problems by themselves, and to inspire students’ enthusiasm for information exploration. The student self-assessment form and teacher evaluation form (as shown in Tables 1 and 2) were used for evaluating the students’ performance. The control and experiment classes completed a posttest after the classroom teaching session; the pre- and posttests used the same 10 items.

Table 1. Student self-assessment form

| Assessment Items                  | Grade |
|----------------------------------|-------|
|                                  | A (8.5–10) | B (7–8.4) | C (6–6.9) | D (<6) |
| Completing task on time          |         |          |          |       |
| Teamwork spirit                  |         |          |          |       |
| Going through reference books    |         |          |          |       |
| Capability of problem-solving    |         |          |          |       |
| Capability of reporting and      |         |          |          |       |
| demonstrating                    |         |          |          |       |
| Capability of innovation         |         |          |          |       |

Table 2. Teacher evaluation form

| Group | Subject | A (8.5–10) | B (7–8.4) | C (6–6.9) | D (<6) | Suggestions |
|-------|---------|------------|-----------|-----------|--------|-------------|
| Group 1 |         |            |           |           |        |             |
| Group 2 |         |            |           |           |        |             |
| Group 3 |         |            |           |           |        |             |
| Group 4 |         |            |           |           |        |             |
| Group 5 |         |            |           |           |        |             |
| Group 6 |         |            |           |           |        |             |
| Group 7 |         |            |           |           |        |             |
| Group 8 |         |            |           |           |        |             |
| Group 9 |         |            |           |           |        |             |
| Group 10 |        |            |           |           |        |             |
| Group 11 |        |            |           |           |        |             |
| Group 12 |        |            |           |           |        |             |

Assessment criteria is as follows (total score: 10). 1) Content organization: familiar with the knowledge; highlight key points; reasonably detailed; clear mind; high logicality (score: 4). 2) Reporting work: proper speed; clear expression; courseware are creative, concise, artistic, and helpful (score: 2). 3) Knowledge application: case discussion; analyze the cause and pathogenesis (score: 3). 4) Interaction: appropriate questions and interactions; active in the atmosphere of the classroom (score: 1).

Ability extension after class. The ability extension after class is important for SPOC. One or two advanced tasks were released after class for the students to reinforce their learning.

The learning processes of the experiment class and control class are shown in Fig. 1.

Questionnaire

The questionnaire was delivered after class, and the respondents were required to complete the questionnaire and submit it on the spot. The contents of the questionnaire and the results are shown in Table 3.

Statistical Analysis

The data are expressed as means ± SD. All data were analyzed using SPSS software. The preclass test and postclass test scores of the control and experiment classes were analyzed by one-way ANOVA, followed by Tukey’s multiple-comparison tests. The contribution of the classroom teaching on improving the postclass test score was analyzed by repeated-measures ANOVA analysis. P < 0.05 was regarded as statistically significant difference.

RESULTS

Questionnaire

The questionnaire showed that 87.8% of the students were very satisfied or satisfied with the SPOC flipped classroom, 84.3% of the students agreed that the SPOC flipped classroom could improve the overall ability of the students more than traditional LBL, and 82.1% of the students liked or really liked the SPOC flipped classroom (Table 3).

The Distribution of Examination Scores

The same test was delivered to both the experiment class and the control class. The control class had 82 students, and the average scores of preclass and postclass tests were 53.46 ± 8.09 and 69.01 ± 12.81, respectively (Fig. 2). The experiment class had 115 students, and the average scores of preclass and postclass tests were 65.13 ± 12.45 and 80.43 ± 14.29, respectively (Fig. 2).
To show the scores more clearly, we divided them into four grades, which are A (85–100), B (70–84), C (60–69), and D (<60). Using this scale, the D grade of the preclass quizzes in the experiment class was obtained by 24.35% of the students compared with 65.43% in the control class, whereas the B grade was obtained by 37.36% of the students in the experiment class compared with 2.47% in the control class. The results are shown in Fig. 3A. In the postclass test, the D grade in the experiment class was obtained by 6.08% compared with 16.05% of the students in the control class. In the experiment class, the A grade was obtained by 43.48% of the students, but by only 4.94% in the control class. The results are shown in Fig. 3B.

**Statistical Analysis of Examination Scores**

To measure whether the SPOC flipped classroom is effective in increasing the overall performance of students, we first compared the preclass and after-class test scores between the control and experiment classes through one-way ANOVA. We found that both the preclass and postclass test scores of the experiment class were significantly higher than those of the control class ($P < 0.001$), and, for each class, the postclass test scores were higher than the preclass test scores ($P < 0.001$) (Fig. 2 and Table 4). These results suggested that the SPOC flipped classroom was effective at enhancing the performance of the students, which reflected an improved learning efficiency. In particular, the significant difference between the preclass scores of the two classes suggested that the video lecture-based preview is more effective than the textbook-based preview.

Whether different classroom teaching methods affected student learning was investigated using repeated-measures ANOVA. Posttest scores were significantly greater than pretest scores in both groups (Table 5). Either the LBL or flipped classroom activity increased learning by a similar amount. However, the experiment group had higher pretest scores than controls, suggesting that the preclass video had an additional significant effect on learning compared with the presumed reading of a textbook.
SPOC is quietly setting off a trend of teaching reform in university education. Professor Robert Lue, the chairman of the Harvard online learning experiment academic committee, believed that a more flexible and refined course like SPOC is an “almost inevitable evolution” (1). In this study, we designed a SPOC flipped classroom blended learning activity. The video lecture allows students to organize the learning materials according to their own requirements and preferences; thus the students were no longer restricted by the limited class hours and environments. In the control group, students performed self-learning using a textbook, and 65.13% of them failed the preclass examination, whereas only 24.35% of the students in the experiment group failed the same examination, which is statistically different from the control class. The SPOC flipped classroom was effective at enhancing the examination scores of students, which reflected an improved learning efficiency and more understanding of the knowledge. Especially, the significant differences between the preclass scores of the two classes suggested that the video lecture-based preview is more effective than the textbook-based preview.

**DISCUSSION**

SPOC is quietly setting off a trend of teaching reform in university education. Professor Robert Lue, the chairman of the Harvard online learning experiment academic committee, believed that a more flexible and refined course like SPOC is an “almost inevitable evolution” (1). In this study, we designed a SPOC flipped classroom blended learning activity. The video lecture allows students to organize the learning materials according to their own requirements and preferences; thus the students were no longer restricted by the limited class hours and environments. In the control group, students performed self-learning using a textbook, and 65.13% of them failed the preclass examination, whereas only 24.35% of the students in the experiment group failed the same examination, which is statistically different from the control class. The SPOC flipped classroom was effective at enhancing the examination scores of students, which reflected an improved learning efficiency and more understanding of the knowledge. Especially, the significant differences between the preclass scores of the two classes suggested that the video lecture-based preview is more effective than the textbook-based preview. However, we also no-

**Table 3. The questionnaire results**

| Research Items | Choice | Results, % |
|----------------|--------|------------|
| Do you agree to using the flipped classroom in teaching? | Strongly agree | 26.1 |
| | Agree | 62.6 |
| | Disagree | 11.3 |
| Which preview material was most helpful in your self-learning? | Online resources | 14.9 |
| | Textbook | 26.1 |
| | Video lectures | 59.0 |
| Are you satisfied with the arrangement of the classroom activities? | Very satisfied | 46.1 |
| | Satisfied | 41.7 |
| | Not satisfied | 12.2 |
| Do you agree that you achieved a more comprehensive understanding of the knowledge through the group discussion and cooperation in the class? | Strongly agree | 60.0 |
| | Agree | 37.4 |
| | Disagree | 2.6 |
| Do you agree that the flipped classroom inspired your interest in learning? | Strongly agree | 73.0 |
| | Agree | 25.2 |
| | Disagree | 1.8 |
| Do you agree that the flipped classroom is better at improving your self-learning ability than traditional lecture-based teaching mode? | Strongly agree | 22.6 |
| | Agree | 70.4 |
| | Disagree | 7.0 |
| Do you agree that the flipped classroom can improve the quality of your comprehension? | Strongly agree | 31.3 |
| | Agree | 53.0 |
| | Disagree | 15.7 |
| Do you like the flipped classroom? | Really like | 44.3 |
| | Like | 47.8 |
| | Dislike | 7.9 |

n = 115 Students.

**Table 4. One-way ANOVA analysis results**

| Test | Mean Difference (95% CI of Difference) | q | P Value |
|------|--------------------------------------|---|--------|
| con-pre vs. con-post | −15.56 (−20.61 to −10.50) | 11.32 | 0.000 |
| exp-pre vs. exp-post | −13.30 (−19.55 to −7.06) | 13.28 | 0.000 |
| con-pre vs. exp-pre | −11.67 (−16.34 to −7.007) | 9.21 | 0.000 |
| con-post vs. exp-post | −11.42 (−16.09 to −6.756) | 9.01 | 0.000 |

CI, confidence interval; con-pre, preclass examination score of control class (n = 82); con-post, postclass examination score of control class (n = 82); exp-pre, preclass examination score of experiment class (n = 115); exp-post, postclass examination score of experiment class (n = 115).
Table 5. Repeated-measures ANOVA analysis result

| Effect            | F-Test  | Degrees of Freedom | P Value |
|-------------------|---------|--------------------|---------|
| Time              | 711.556 | 192.000            | 0.000   |
| Time × group      | 0.025   | 192.000            | 0.875   |
| Time × sex        | 0.801   | 192.000            | 0.372   |
| Time × group × sex| 0.552   | 192.000            | 0.458   |

The posttest score was analyzed by repeated-measure ANOVA using Pillai’s trace. The factor “Time” showed significant relationship with the scores, which suggests a difference between pre- and post-scores. However, the factor “Time X group” does not affect the score difference ($P = 0.875$), which suggests that different classroom teaching methods do not contribute to the improvement of scores. $P < 0.05$ was regarded as statistically significant difference.

noticed that the postclass examination scores of both classes were significantly higher than their preclass examination scores, which also indicated positive learning gains from LBLs.

In this study, we provided students with a three-step learning process, which is “preclass self-study—in-class knowledge internalization—after-class ability extension.” We integrated SPOC videos into the learning process so that students could achieve a better learning effect through “speak and operate.”

Classroom teaching is a key factor that could influence the effect of SPOC, and effective classroom teaching depends on successful arousal of the students’ motivation for learning. Psychologist Dr. John M. Keller developed the ARCS theory of motivational learning, which proposed four components: attention (A), relevance (R), confidence (C), and satisfaction (S) (3, 4). The classroom teaching should be able to fully develop the attention, relevance, confidence, and satisfaction of students. In our SPOC flipped classroom, the instructors performed the roles of organizers and directors, and every 8–10 students formed a learning group to finish the learning tasks cooperatively, so that each one of the students could actively participate in learning. The design of the classroom teaching showed the motivational model of “attention” and “relevance,” and the students were able to solve problems through friendly mutual interaction in a relaxed classroom environment, which greatly enhanced their self-satisfaction and self- accomplishment. The questionnaire showed that 73% of the students felt an increase in their interest in learning. 87.8% of the students were very satisfied or satisfied with the SPOC flipped classroom, 84.3% of the students agreed that the SPOC flipped classroom could improve the overall ability of the students more than the traditional LBL, and 82.1% of the students liked or really liked the SPOC flipped classroom. The questionnaire could not be given to the control group for comparison, since the questions were related to the SPOC activity. However, there are some illuminating findings when we compare the results of the questionnaire with the statistical analysis of the scores: 70% of the student response rated videos as very helpful, which is consistent with what we found to be the effect of videos on grades.

In conclusion, in this study, we applied the flipped classroom model based on SPOC in a physiology course, through integrated online video lectures, to the teaching process. Furthermore, we designed a “preclass self-study—in-class knowledge internalization—after-class ability extension” learning paradigm in which SPOC became a combination of online learning and classroom lecturing, thus providing the students with a platform for effective self-learning to promote their understanding of the knowledge. The results indicated that the classroom activities in both the LBL control and SPOC groups improved learning, but there was an additional enhancement associated with SPOC video preview in the experiment group.

GRANTS

This study was supported by the scientific research fund project of the Education Department of Yunnan (2015Z086); the undergraduate teaching reform research program of Kunming Medical University (2017-JY-Z-04); the blending course construction project of Kunming Medical University (J201307506); and the model course of curriculum politics of Kunming Medical University (J1301307609).

DISCLAIMERS

The funders had no role in study design, data collection, and analysis, decision to publish, or preparation of the manuscript.

DISCLOSURES

No conflicts of interest, financial or otherwise, are declared by the authors.

AUTHOR CONTRIBUTIONS

X.-M.Z., Y.Y., C.-P.F., J.L., and S.-L.X. performed experiments; X.-M.Z. drafted manuscript; X.-M.Z., J.-Y.Y., and S.-L.X. edited and revised manuscript; J.-Y.Y. and S.-L.X. interpreted results of experiments; S.-L.X. conceived and designed research; S.-L.X. analyzed data; S.-L.X. prepared figures; S.-L.X. approved final version of manuscript.

REFERENCES

1. Coughlan S. Harvard plans to boldly go with “SPOCs” (Online). BBC News. https://www.bbc.co.uk/news/business-24166247 [24 Sept 2013].
2. Fox A. From MOOCs to SPOC. Commun ACM 56: 38–40, 2013. doi:10.1145/2535918.
3. Keller JM. Development and use of the ARCS model of instructional design. J Instruct Dev 10: 2, 1987. doi:10.1007/BF02905780.
4. Keller JM. Motivational Design for Learning and Performance: The ARCS Model Approach. New York: Springer Science & Business Media, 2010.
5. Liang JN. Research on building mixed teaching mode of MOOC, SPOC and traditional classroom: case study of information retrieval course. Information Res 5: 26–31, 2017.
6. Lockhart BJ, Capurso NA, Chase I, Arbuckle MR, Travis MJ, Eisen J, Ross DA. The use of a small private online course to allow educators to share teaching resources across diverse sites: the future of psychiatric case conferences? Acad Psychiatry 41: 81–85, 2017. doi:10.1176/arp40596-015-0460-4.
7. Michael J. What makes physiology hard for students to learn? Results of a faculty survey. Adv Physiol Educ 31: 34–40, 2007. doi:10.1152/advan.00057.2006.
8. Pappano L. The year of the MOOC. The New York Times Nov. 4, 2012.
9. Paton C. Massive open online course for health informatics education. Healthc Inform Res 20: 81–87, 2014. doi:10.4258/hr.2014.20.2.81.
10. Sefton AJ. Charting a global future for education in physiology. Adv Physiol Educ 29: 189–193, 2005. doi:10.1152/advan.00001.2005.
11. Uijl S, Filius R, Ten Cate O. Student interaction in small private online courses. Med Sci Educ 27: 237–242, 2017. doi:10.1007/s40670-017-0380-x.