Evaluating Student Perceptions and Performance of Active Learning Strategies in a Pharmacotherapy Course

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Learning-preferences vary and thus it is beneficial for students to experience a variety of active-learning pedagogies for meaningful learning and long-term retention. This novel study attempted to evaluate systematically and longitudinally, student perceptions of multiple formats of active-learning strategies. Four different active-learning strategies were utilized in a course - team-based-learning (TBL), case-study, flipped-classroom, and interactive-technology. Student perspectives indicated active-learning strategies were helpful for learning. Faculty in higher-education could implement active-learning strategies in their courses for enhanced student-engagement, long-term retention, and success. This easily replicable method of collecting student perceptions on learning-experience anonymously enables learner-centered course design and promotes continuous-quality-improvement in higher-education.

Keywords: active learning, pharmacy, team-based learning, case study, flipped classroom, interactive technology

INTRODUCTION

The Accreditation Council for Pharmacy Education (ACPE, 2016) in their accreditation standards require Doctor of Pharmacy programs to promote and emphasize active learning strategies in their curriculum. Active learning strategies engage the learners in acquiring the knowledge. It has been shown to promote learning, retention and improve learning experiences of the learners (Freeman et. al., 2014; Stewart et.al., 2011). There are several studies showing how active learning strategies have been used in higher education in the recent years (Slain, et.al., 2004; Mclean, & Stefanie, 2018; Samuel, 2019).

The theoretical and philosophical foundations of active learning strategies are based on Constructivist Learning Theories (Fosnot, 1996). Constructivism is a philosophy of learning that has origins both in philosophy and psychology and was heavily influenced by views of Lev Vygotsky and John Dewey (Vygotsky, 1978; Dewey, 1938). According to the constructivist theories of learning, we learn by actively constructing new knowledge and meanings based on our experiences, both individually and socially.

Activity theory by Vygotsky focuses on the interaction of human activity and consciousness within the environment in which the interaction takes place (Jonassen & Rohrer-Murphy, 1999). The assumptions of Activity theory framework reflect in parts the characteristics used to describe constructivism, situated learning, case based learning and social cognitive theories which all are based on designing constructivist learning environments.

Based on the ACPE Standards, faculty of pharmacy have implemented various active learning pedagogies within the pharmacy curriculum (ACPE, 2016). Each of these strategies offer benefits towards learning and student engagement. There is a paucity of studies in the literature of pharmacy education that has reported a systematic and longitudinal collection of student perceptions comparing various active learning strategies for continuous quality improvement (CQI) of courses. Systematic collection of student perception of learning experiences and monitoring student exam performance is also very critical following any major curricular revision, a course re-design or following any change in instructional strategies.

Therefore, this study examines the effects of using multiple active learning strategies in a newly designed and implemented pharmacotherapy course. In this mixed methods study, we: (i) describe a systematic process for collection of student perceptions on their learning experience with the various active learning strategies and (ii) compare the student perceptions on active learning to evaluate the strategy/strategies that students found most beneficial towards learning. We also report on the longitudinal aggregate performance of the students in a first year Pharmacotherapy course during Winters 2017, 2018 and 2019.

EDUCATIONAL ACTIVITY AND SETTING

This Institutional Review Board approved longitudinal study was conducted in an urban, public, research-intensive university in the mid-west of USA. The pharmacy program went through a major curricular renewal process during 2014 – 2015. The renewed curriculum courses were implemented with the entering first year Doctor of Pharmacy class during Fall 2016. All students in the Doctor of Pharmacy program are required to take Pharmacotherapy I in the winter semester of their first year. The first implementation of this Pharmacotherapy course was during winter 2017. In this Pharmacotherapy course, students are taught principles of medicinal chemistry, pharmacology and therapeutics that are applied to the treatment of gastrointestinal, pulmonary, ophthalmologic, allergic disorders, and basic self-care. A Pharmacy faculty coordinates the course and there are several faculty teaching the different disease states that are covered in the course. The individual faculty, the topics each of them taught, the teaching strategy they incorporated, and the overall course coordinator remained same throughout the course of this study.

Participants in this three-year longitudinal study were the students enrolled in the first Pharmacotherapy module during winter semesters of 2017, 2018 and 2019. The first Pharmacotherapy module incorporated a variety of active learning strategies including team-based learning (TBL), case study, flipped classroom and use of interactive technology. The Table 1 describes the various forms of active learning and how they were implemented in the course.

TABLE 1
ACTIVE LEARNING STRATEGIES

Active Learning Strategy	Pre-work	In-Class Activity	Assessment
TBL (Farland, et. al., 2013) (Team Based Learning)	Reading materials and supplemental materials uploaded to the learning management system (Blackboard/Canvas) about a week prior to the class	● Individual Readiness Assessment Test (IRAT) ● Team Readiness Assessment Test (TRAT) ● Team problem solving of patient cases	Formative: ● IRAT score ● TRAT score Summative: Examinations
Case Study (Pierce, et. al., 2012)	Reading materials and supplemental materials uploaded to the learning management system (Blackboard/Canvas) about a week prior to the class	● Traditional lecture/discussion ● Active individual participation/interaction in patient case resolution of pharmaceutical care problems by application of content from pre-work	Formative: In-class problem solving Summative: Examinations
Flipped Classroom (McLean & Attardi, 2018; Samuel, 2019; McLaughlin et. al., 2014)	Reading materials and supplemental materials uploaded to the learning management system (Blackboard/Canvas) about a week prior to the class	● Team problem solving of patient cases	Formative: In-class problem solving Summative: Examinations
Interactive Technology (Slain et. al., 2004)	Reading materials and supplemental materials uploaded to the learning management system (Blackboard/Canvas) about a week prior to the class	● Traditional lecture/discussion ● Application of content from learning materials to patient related pharmaceutical care problems using TurningPoint® (https://www.turningtechnologies.com/turningpoint/), PollEverywhere® (https://www.polleverywhere.com/)	Formative: In-class quiz using PollEverywhere® and TurningPoint ® Summative: Examinations

Student Evaluation of Teaching (SET) for each course is a university requirement and is usually performed during the last two weeks of the semester. The university SET form allows addition of optional up-to ten instructor supplied items to be added to the SET form. Each year the students were provided a list of statements as instructor supplied items with the university conducted anonymous SET form. The instructor supplied statements were designed to gather student perspectives of their learning experiences with the different active learning strategies (Figure 1). Data was collected from student responses to instructor provided items using the university's scale for SET: 5= Strongly Agree, 4 =Agree, 3 = Neutral/Undecided, 2 = Disagree, 1 = Strongly Disagree. Participation in the study was voluntary and had no impact on their course grade. All data collected with the anonymous SET forms were tabulated by the university's Testing, Evaluation and Research Services and the report was sent to the faculty member who

coordinated the course. The tabulated data from the report was extracted and the student perception data was analyzed using MS Excel.

FIGURE 1
INSTRUCTOR SUPPLIED ITEMS

1. The pre-work activities I self-studied at home were very helpful to my learning.
2. The workload for the assigned pre-work, for the respective instructional sessions, was manageable.
3. The pre-work helped discover the course content on my own before being taught by the instructor.
4. Team Based Learning (TBL) was very effective to my learning.
5. Instructor explanation followed by a case study in-class was very effective to my learning.
6. Pre-work followed by in class group presentations (flipped classroom) was very effective to my learning.
7. Active learning with the interactive technology (e.g. Clickers or Poll anywhere) during class was very effective to my learning.
8. Rate the following as most preferred active learning strategy:
    - TBL
    - Case study
    - Flipped classroom
    - Interactive technology
9. Rate the following as least preferred active learning strategy:
    - TBL
    - Case study
    - Flipped classroom
    - Interactive technology

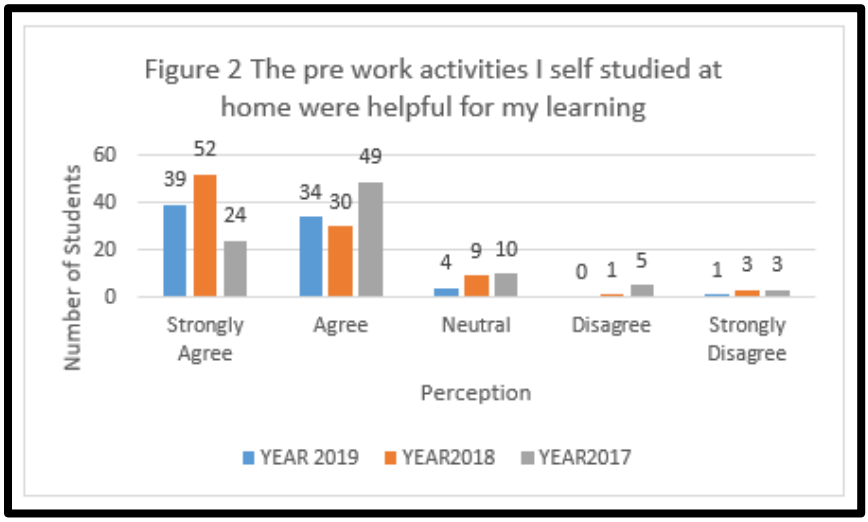
Descriptive statistics was used to characterize student performance in the course. The content exam included a mix of multiple choice, and True/False questions that were patient case scenario based or based on identification of medicinal chemistry structures or evaluating the best treatment strategy depending on patient history/characteristics. The questions in the content exam all mapped to Knowledge/Application/ Analysis/Evaluation levels of Bloom's Taxonomy with few knowledge-based questions and majority questions at the Application level. The aggregate performance of students in each implementation of the course was evaluated using the Mean and the Standard Deviation of the final course grade. One way ANOVA was run to compare the means of the participants from Winter 2017, Winter 2018 and Winter 2019 of the Pharmacotherapy course. All quantitative data analysis was run using Statistical Package for Social Sciences (SPSS, 25)

FINDINGS

Qualitative Data

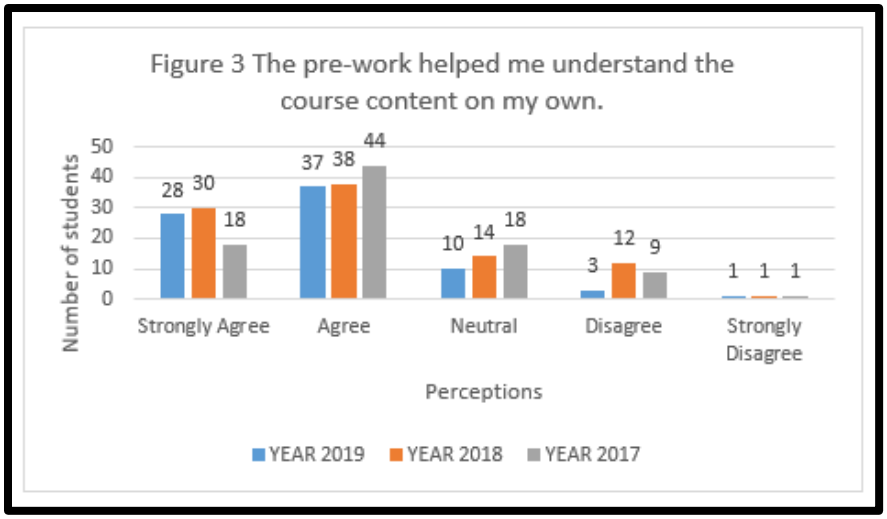
The longitudinal qualitative data for the three years was extracted from the SET report and tabulated on MS Excel. One of the questions that was asked was whether the pre-work activities for self-study prior to the active learning sessions were helpful towards learning experience. Figure 2 shows the graphical representation of the responses for the three years.

FIGURE 2
PRE-WORK ACTIVITIES AND COURSE LEARNING



It is evident that there is an increase in the students who strongly agree that the pre-work was helpful from 2017 to 2018 and 2019. This course was offered for the first time during 2017 winter and hence it is possible that the pre-work activities were refined in delivery in the later years with experience by the teaching faculty. In addition, students in winter 2017 did not have any feedback about the course from their predecessors, which may have impacted their responses. However, if the "strongly agree" and "agree" responses are combined, then there does not seem to be a big difference between the three years. The students also thought that the pre-work was helpful for understanding the course content on their own, as depicted in Figure 3.

FIGURE 3
PRE-WORK AND SELF STUDY



The responses to the workload question were similar to the responses for the "pre-work activities were helpful towards learning" (Figure 4). The winter 2017 class had the lowest scores for the workload being

manageable. Class responses to the "pre work activities" for "Strongly Agree" and "Agree" were similar except for 2017.

FIGURE 4
PRE-WORK AND WORKLOAD

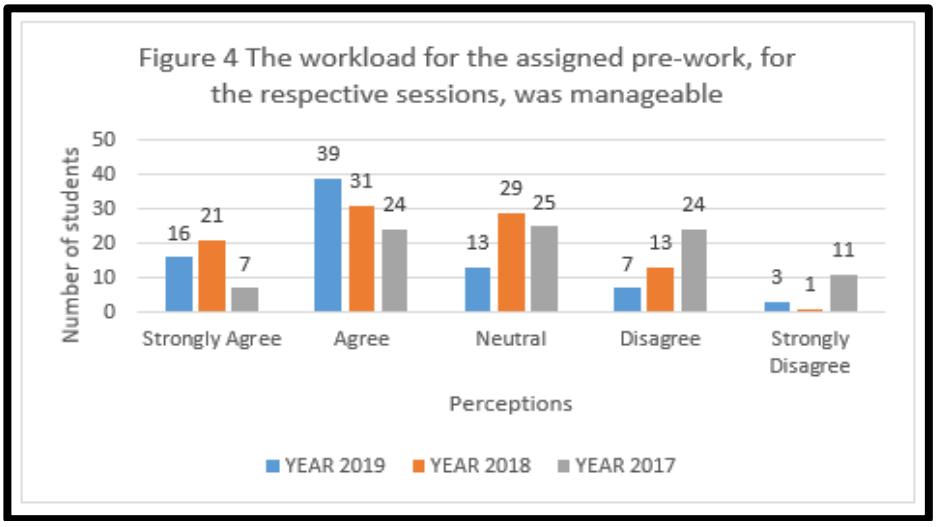
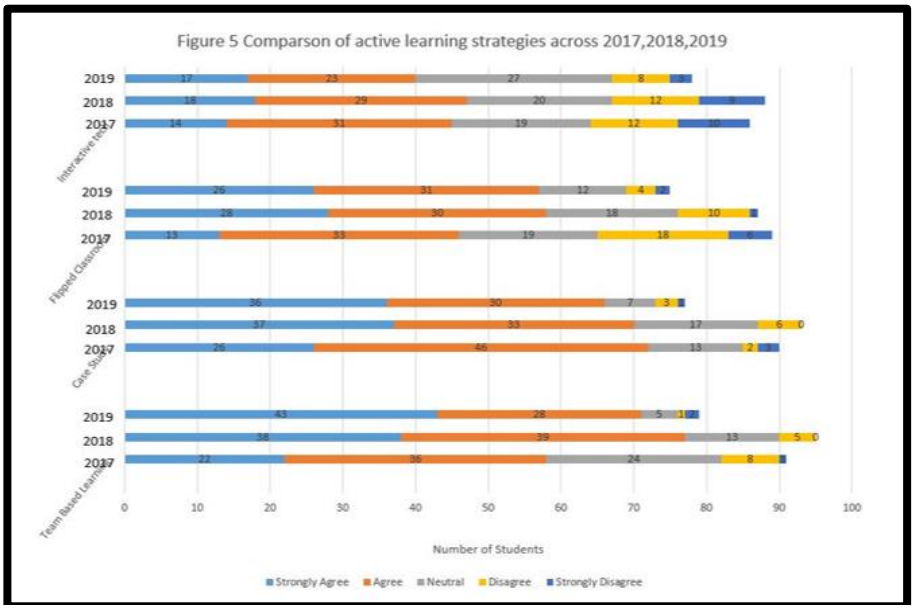


Figure 5 shows the students' perspectives of the different active learning strategies used in the course. As evident from the figure, students in all three years, found Team Based Learning (TBL) most helpful towards their learning, followed by Case Study and Flipped Classroom. The students found that learning with interactive technology was not as helpful as the other active learning strategies. Over the three years, students strongly agreed or agreed that active learning strategies were beneficial.

FIGURE 5
COMPARISON OF ACTIVE LEARNING STRATEGIES



Quantitative Data

SPSS was used to run descriptive statistics on the students' performance data from 2017-2019. Table 2 shows the mean and standard deviation of the final course grades. The mean grades for 2017 and 2018 were similar however, the mean final grade for 2019 was lower than the previous years. Levene's statistic of the final grades was greater than 0.05 and hence there is homogeneity of variances between the three groups. One-way ANOVA was used to determine the difference in performance between the groups. This test showed a significant difference in the final grades between the groups ($p = 0.003$). Post hoc tests were run to determine where the significant differences existed. There was no significant difference between 2017 and 2018 ($p = 0.918$). However, there was a significant difference in the performance of the 2017 and 2019 cohorts ($p = 0.005$). The performance of the 2018 and 2019 cohorts was also significant ($p = 0.014$).

TABLE 2
STUDENT PERFORMANCE DATA FROM FINAL GRADES

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval	Minimum	Maximum
2017	102	84.57	5.71	0.57	83.45-85.69	70.00	97.00
2018	111	84.25	6.39	0.61	83.05-85.45	68.00	96.00
2019	95	81.94	5.36	0.55	80.85-83.03	68.63	94.67
Total	308	83.64	5.96	0.34	82.98-84.31	68.00	97.00

DISCUSSION

The study describes a novel and systematic method of designing a learner centered course in the Doctor of Pharmacy curriculum. Collecting feedback from students on learning experiences is critical for a learner centered environment design and a systematic and powerful yet easy to implement method of collecting this information can be Student Evaluation of Teaching (SET) tool. The SET allows the student to provide anonymous feedback on learning experience without the fear of being identified by the instructor and thus eliminates any bias. This study reports students' perspectives of the multiple active learning strategies that were used in a first year Doctor of Pharmacy Pharmacotherapy course over a period of three years. This course was first implemented in the winter 2017 semester and incorporated various formats of active learning pedagogies. There are reports in the Pharmacy and other health sciences literature on using one active learning strategy and its impact on student performance (Farland, et. al., 2013; Pierce & Fox, 2012; McLaughlin, et. al., 2014; Jensen, Kummer & Godoy, 2015). However, to the best of our knowledge, this is one of the first studies evaluating students' perspectives on utilizing four different active learning strategies in the same pharmacotherapy course and over a three-year period. The qualitative data showed that the pre-work for the active learning sessions were helpful for the students' learning. The students also reported that the workload for all active learning strategies used in the study were manageable. Of the four active learning strategies used in this course (TBL, Case Study, Flipped Classroom and Interactive Technology) TBL was best received by the students. All four active learning strategies had both formative and summative assessments associated with them. However, the TBL formative assessment, especially the TRAT component had a major positive impact on the students' final grades. This may have contributed to the students overwhelming agreement that TBL was beneficial to their learning in comparison to the other strategies. Another study comparing TBL to mixed active learning methods in an elective pharmacy course has shown that although students were satisfied with both TBL and other active learning strategies, their performance were higher with the TBL strategy (Zingone, et. al., 2010). A recently published study compared benefits of various web-based strategies to student learning in a pharmacology course (Sumanasekera, et. al., 2020). The strategies used in the study were Kahoot web based interactive games, crossword puzzles, interactive videos, music video and fill-in-the-blank tables. The study reported that students taught using these strategies performed better overall than students who attended traditional lecture

method. Students perceived gaming with Kahoot as the most beneficial active learning strategy. The active learning strategies reported by the above study are mostly strategies using technology-based teaching tools and are very different from the active learning pedagogies and findings that are reported in this study. In addition, the recent study (Sumanasekera, et. al., 2020) utilized anonymous surveys for collecting their data, which was much different from the current study. In this study, we utilized the university SET forms for anonymous data collection on student perception, which may have eliminated any instructor bias in student feedback.

Studies in the areas of medical education, pharmacy education and other higher education setting have reported positive results with student satisfaction and performance with the use of flipped classrooms as an active learning strategy (Samuel, 2019; McLaughlin, 2014; Jensen, Kummer & Godoy, 2015). The findings of the current study concur with findings reported by Jensen (2015) and colleagues. Our analysis indicates that the students found the flipped classroom strategy beneficial to their learning although flipped classroom was ranked lower than TBL and case studies as active learning strategies. The interactive technology was the least preferred active learning strategy of the four that were used in this study. However, there is paucity of literature in pharmacy education using interactive technology (Slain, et. al., 2004).

The performance data analysis for this study indicated no significant difference between 2017 and 2018 cohorts. However, there was a statistically significant difference in the performance of students between 2019 and 2017/2018 cohorts. The same instructor coordinated the course for all three years; the course content remained similar across the three years and was taught by the same instructors using the same strategies. One possible explanation for the slight difference in performance may be the change in the admissions criteria to the Doctor of Pharmacy program implemented in Fall 2019. Until the Fall of 2018, students entering the program had to meet two minimum criteria (prerequisite Grade Point Average (GPA) $\geq$ 3.0 and Pharmacy College Admission Test (PCAT) composite scores $\geq$ 50th percentile). In 2019, the Doctor of Pharmacy applicants only had to meet one hard minimum criteria of prerequisite GPA $\geq$ 3.0. The GPA scales vary across institutions that students may attended which may have impacted the overall course performance in Winter 2019. However, it is noteworthy as noted in Figure 5 that the student perceptions of learning experiences with the active learning strategies during 2019 were positive and comparable to 2017 and 2018.

LIMITATIONS

This study does have some limitations. This was a new course started in winter 2017, and we could not compare the results with and without the active learning strategies. Also, since we do not have multiple sections of the same course in the institution, a control and treatment group study design could not be implemented. To address this limitation, we collected data on student learning experiences across three years in the same course to have longitudinal perspective. Moreover, the winter 2017 students did not have any students from past year to mentor them with the course processes, which may have impacted their responses.

The study results being perspectives of students about learning experiences, are not generalizable. Learning experiences can vary, depending on the student population, including student background and preparation as well as on the learning environment which includes the faculty and other resources of the institution. However, this study is unique as it provides a systematic method of longitudinal assessment of student perspectives on the four active learning strategies utilizing the SET and can be replicated easily at other institutions. Students have different learning preferences, and it may be beneficial for students to experience a variety of active learning pedagogies within a course. Future studies may explore potential influence of student preparation prior to entering the Doctor of Pharmacy program and their performance in the program. We intend to collect feedback and track performances of students in this course to ascertain the correlation between pre-pharmacy student preparation and their performance in the course.

CONCLUSION

This longitudinal mixed methods study explored the student perceptions of the various active learning strategies in a newly designed pharmacotherapy module. Students found the active learning strategies to be helpful to their learning. All active learning strategies described in this study may be easily implemented in any discipline with minimal additional resources and can enhance student learning. This novel and easily replicable method of collecting student perceptions on learning with the SET enables learner centered course design and promotes continuous quality improvement initiative in higher education.

REFERENCES

ACPE. (2016). *Accreditation Standards and Key Elements for the Professional Program in Pharmacy Leading to the Doctor of Pharmacy Degree*. The Accreditation Council for Pharmacy Education, Chicago, IL. Retrieved from https://www.acpe-accredit.org/pharmd-program-accreditation/

Dewey, J. (1938). *Experience and education*. New York, NY: Macmillan.

Farland, M.Z., Sicat, B.L., Franks, A.S., Pater, K.S., Medina, M.S., & Persky, A.M. (2013). Best practices for implementing team-based learning in pharmacy education. *Am J Pharm Educ*, *77*(8), Article 177. doi:10.5688/ajpe778177

Fosnot, C.T. (1996). Constructivism: A psychological theory of learning. In *Fosnot CT, Constructivism: Theory, perspectives, and practice* (pp. 8–33). New York: Teachers College Press, Inc.

Freeman, S., Eddy, S.L., McDonough, M., Smith, M.K., Okoroafor, N., Jordt, H., & Wenderoth, M.P. (2014). Active learning increases student performance in science, engineering, and mathematics. *Proceedings of the National Academy of Sciences*, *111*(23), 8410–8415. doi.org/10.1073/pnas.1319030111

Jensen, J.L., Kummer, T.A., & Godoy, P.D. (2015). Improvements from a Flipped Classroom May Simply Be the Fruits of Active Learning. *CBE—Life Sciences Education*, *14*, 1–12. doi.org/10.1187/cbe.14-08-0129

Jonassen, D.H., & Rohrer-Murphy, L. (1999). Activity theory as a framework for designing constructivist learning environments. *ETR&D*, *47*(1), 61–79. https://doi.org/10.1007/BF02299477

McLaughlin, J.E., Roth, M.T., Glatt, D.M., Gharkholonarehe, N., Davidson, C.A., Griffin, L.M., . . . Mumper, R.J. (2014). The Flipped Classroom: A course redesign to foster learning and engagement in a health professions school. *Academic Medicine*, *89*(2), 236–243. https://doi.org/10.1097/acm.0000000000000086

Mclean, S., & Stefanie, M.A. (2018). Sage or Guide? Student Perceptions of the Role of the Instructor in a Flipped Classroom. *Active Learning in Higher Education*: *Online First*, 1–13. doi:10.1177/1469787418793725

Pierce, R., & Fox, J. (2012). Vodcasts and active-learning exercises in a "flipped classroom" model of a renal pharmacotherapy module. *Am J Pharm Educ*, *76*(10), Article 196. doi:10.5688/ajpe7610196

Samuel, M.L. (2019). Flipped Pedagogy and Student Evaluations of Teaching. *Active Learning in Higher* Education: Online First, 1–10. doi:10.1177/1469787419855188

Slain, D., Abate, M., Hodges, B.M., Stamatakis, M.K., & Wolak, S. (2004). An Interactive Response System to Promote Active Learning in the Doctor of Pharmacy Curriculum. *American Journal of Pharmaceutical Education*, *68*(5), 117. https://doi.org/10.5688/aj6805117

Stewart, D.W., Brown, S.D., Clavier, C.W., & Wyatt, J. (2011). Active-learning processes used in US pharmacy education. *Am J Pharm Educ*, *75*(4), 68. doi:10.5688/ajpe75468

Sumanasekera, W., Turner, C., Ly, K., Hoang, P., Jent, T., & Sumanasekera, T. (2020). Evaluation of multiple active learning strategies in a pharmacology course. *Curr Pharm Teach Learn*, *12*(1), 88–94. doi:10.1016/j.cptl.2019.10.016

Vygotsky, L.S. (1978). *Mind in society: The development of higher psychological process*. Cambridge, MA: Harvard University Press.

Zingone, M.M., Franks, A.S., Guirguis, A.B., George, C.M., Howard-Thompson, A., & Heidel, R.E. (2010). Comparing Team-Based and Mixed Active-Learning Methods in an Ambulatory Care Elective Course. *American Journal of Pharmaceutical Education*, *74*(9), 1–7. https://doi.org/10.5688/aj7409160