

Background

Historically, students have relied on spending more time physically in the classroom to master challenging subjects. However, in response to the pandemic, numerous institutions transitioned towards an emphasis on remote learning which focuses on self-learning from video lectures.¹

A flipped classroom (FC) model refers to a teaching approach in which students are provided learning materials through resources such as videos, articles, or other asynchronous content relating to the topics being taught before the synchronous session. Ideally, this approach empowers students to study at their own pace before entering the classroom. Following Bloom's Taxonomy, the student is hypothetically equipped to engage in active learning activities and discussions to further solidify their comprehension and achieve higher learning objectives. With this approach, students may take greater control of their own learning, collaborate with their peers, apply the knowledge, and seek clarification through questioning.² When applied correctly and combined with full student engagement, the FC model has the potential to yield higher levels of academic success, including improved grades, enhanced retention of the curriculum, and higher test scores, as compared to the traditional classroom (TC) model.^{3,4}

We were particularly interested in this topic since here has been a noticeable 6.7% decline in the overall national NAPLEX pass rates from 2015 to 2016 which highlight the opportunity to improve the readiness of student pharmacists as they prepare for their future roles in residencies and other pharmacy practices. Therefore, there is a strong imperative to optimize the class design of classroom settings within the pharmacy curriculum to maximize an individual's educational journey to facilitate a seamless transition from student to pharmacist.⁷

Objective

The objective of this study is to investigate the flipped classroom model, specifically identifying indicators of academic success in the flipped classroom teaching model that will demonstrate the most successful learning outcomes for both students and facilitators.

This study will involve a comprehensive review of literature on FC learning and asynchronous/synchronous courses and synthesizing these features from multiple trials. We will be examining how the implementation of the different teaching styles impact the learning endpoints and the overall academic performance of the students.

Discussion

Achieving successful learning outcomes requires successful coordination between students and facilitators. The effectiveness of FC learning may be diminished if either the student or facilitator fails to fulfill their respective roles. In addition, each facilitator may execute their course differently, by incorporating varying pre-work activities and running the in-person activities inconsistently. The burden of watching hours of lecture videos before stepping foot in class can cause students to devalue the information in the videos.⁵ Therefore, should students fail to fulfill their responsibility of completing the pre-class materials or attending the synchronous class, the effectiveness of the in-class instruction may be compromised as it requires retrieval of previous knowledge.² As a result, the flipped classroom experience will not be made equal for every student.

Methods

The **PubMed MeSH** search strategy used was: ("Education, Medical"[Mesh] OR "Education, Pharmacy"[Mesh] OR "Education, Nursing"[Mesh]) AND flipped classroom.

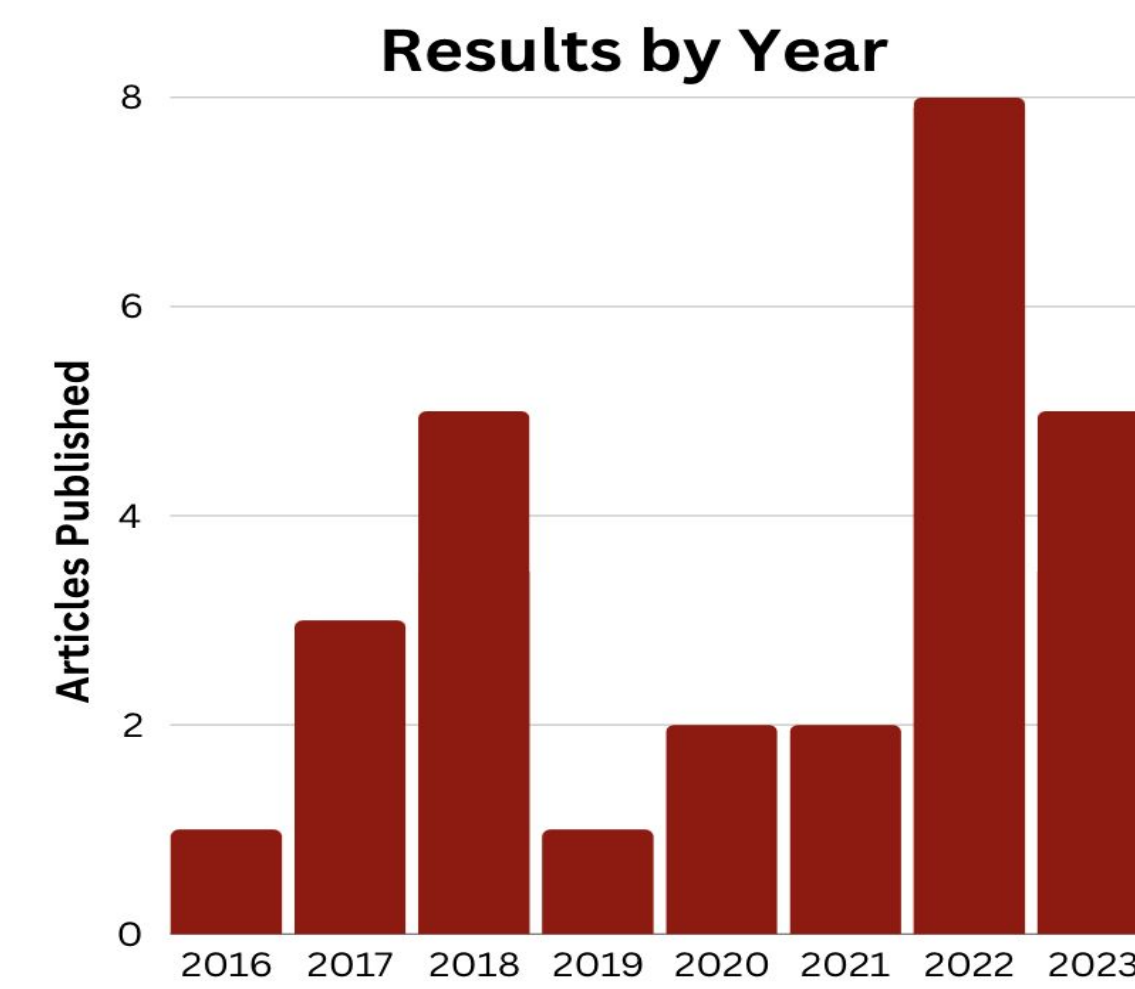


Figure 1. Number of screened articles on flipped classroom models published over the years.

This search yielded 447 articles, which were narrowed down to 25 potential articles to manually screen after filtering for randomized controlled trials and clinical trials per inclusion criteria. The articles were then screened with the following inclusion and exclusion criteria to sort the eligible articles that meet our objective.

Inclusion Criteria

- Full-time healthcare students.
- World-wide programs.
- Flipped-classroom models (defined as separate and different asynchronous and synchronous content).
- Studies from year(s) 2000-2023.

Exclusion Criteria

- Information taught exclusively online or in-person
- Comparison of traditional models to synchronous simulations (defined as demonstrations, acting)
- Asynchronous material provided post-synchronous content.

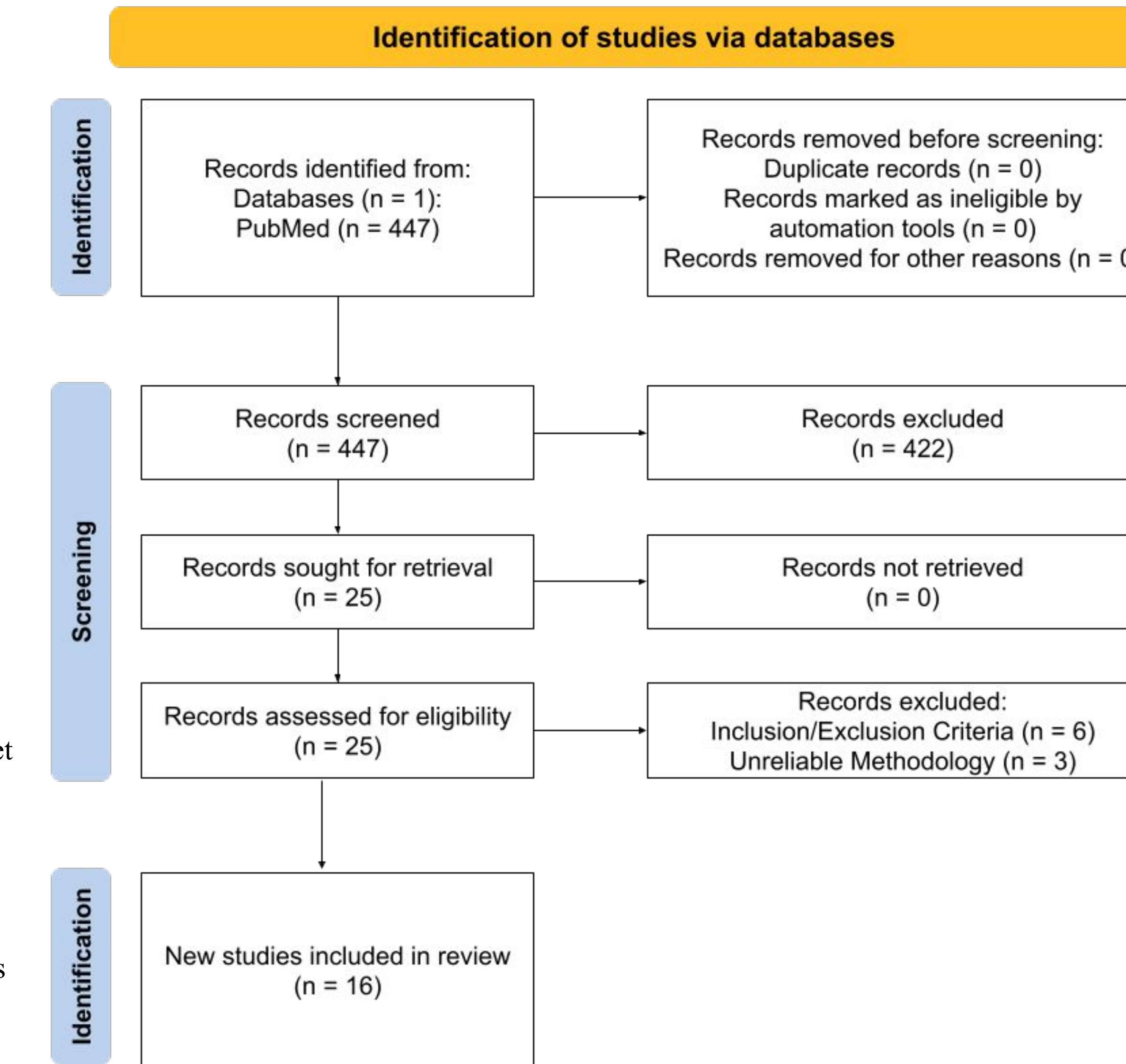


Figure 2. The flow of information and screening process as modeled by the PRISMA 2020 flow diagram.⁸

Results

All sixteen studies utilized recorded videos, seven utilized assessment questions, six utilized e-resources, four utilized readings, one utilized clinical cases, and one utilized presentations as part of the asynchronous, pre-classroom content for their respective intervention FC groups. The improvement in testing scores by FC groups compared to TC groups demonstrates that academic success is attributed to FC indicators including, but not limited to video lectures, assessment questions, and diverse e-resources. Although all sixteen studies used at least asynchronous videos to teach the intervention groups, not all videos were equivalent. One study determined the FC lecture videos with interpolated questions yielded better testing performance than plain lecture videos.⁹ Another study utilized videos with embedded questions and found higher mean scores than the control group.¹⁰ Length of asynchronous videos are divided the studies as some presented lasted between 10 - 15 minutes whereas other may extend to as long as 30 minutes to an hour.^{10, 11, 12} Some of the e-resources implemented in the FC models consisted of various online modules, courseware, programs, exercises, and discussion boards.

The effectiveness of examination scores and satisfaction captured by surveys were analyzed to explore the validity of the aforementioned indicators of academic success in FC learning. Out of the sixteen studies included in this review, eleven studies (68.75%) showed a statistically significant ($p < 0.05$) improvement in examination scores assessing the FC model to the TC model. Two (12.5%) demonstrated statistically insignificant improvements, one (6.25%) concluded mixed results, and two (12.5%) focused on other outcomes. Although most of the studies found favorable outcomes in the FC technique, it is important to note that some studies found the assessment scores, compared between the intervention and control groups, to be statistically insignificant.^{11, 13, 14, 15} At a minimum, performance and retention were not found to be inferior in the FC when compared to the TC. Notably, the FC model showed better long-term retention, student satisfaction, and group collaboration than the traditional model. The four primary improved academic outcomes from the implementation of FC learning compared to TC learning are: knowledge retention, student satisfaction, interaction, and complex problem-solving.^{9, 10, 12, 13, 16, 17, 18, 19, 20, 21, 22, 23, 24} As described by Bloom's Taxonomy, the pre-classwork allows for the application of already established knowledge in more complex in-person discussions and activities to result in higher satisfaction, activeness, and understanding.

According to conducted surveys, students found that the FC approach allowed for closer interactions with instructors and received more clinically-relevant knowledge in comparison to TC. However, some studies showed some students struggling with the additional time required to participate in flipped classrooms. Compared to TC approach, FC stands out for its promotion of active learning and self-paced study, as well as its provision of flexible access to learning materials. Additionally, it encourages asking questions and applying acquired knowledge within the synchronous session.

Limitations

Several articles on the topic rely primarily on qualitative evidence, such as student preferences, rather than quantitative data to illustrate outcomes. Additionally, many studies feature small population sizes, potentially limiting the generalizability of findings. It's also worth noting that results may not directly apply to USC Mann Pharmacy Students since the scope of this research extends beyond pharmacy education to encompass all healthcare providers. This could introduce variations in findings based on different educational backgrounds and contexts.

Conclusion

The indicators of academic success in flipped classroom learning include asynchronous videos, assessment questions, and e-resources to make opportunities for active learning and group discussions within the synchronous classroom.

However, it's important to acknowledge that the applicability of the FC approach may vary across different programs and classes. Its effectiveness is dependent on several factors including quality of the asynchronous materials, alignment with program-specific learning objectives, and responsiveness to the individualized needs and contributions of students.

References

1. Mostafa S, Cousins-Cooper K, Tankersley B, Burns S, Tang G. The impact of COVID-19 induced emergency remote instruction on students' academic performance at an HBCU. *PLoS One*. 2022;17(3):e0264947. doi:10.1371/journal.pone.0264947
2. Chen T, Luo H, Wang P, Yin X, Yang J. The role of pre-class and in-class behaviors in predicting learning performance and experience in flipped classrooms. *Heliyon*. Apr 2023;9(4):e15234. doi:10.1016/j.heliyon.2023.e15234
3. McLaughlin JE, Griffin LM, Esserman DA, et al. Pharmacy student engagement, performance, and perception in a flipped satellite classroom. *Am J Pharm Educ*. Nov 12 2013;77(9):196. doi:10.5688/ajpe779196
4. White PJ, Naidu S, Yuriev E, Short JL, McLaughlin JE, Larson IC. Student Engagement with a Flipped Classroom Teaching Design Affects Pharmacology Examination Performance in a Manner Dependent on Question Type. *Am J Pharm Educ*. Nov 2017;81(9):5931. doi:10.5688/ajpe5931
5. Park SK, Phillips J, Pavuluri N. Systematic Review of Predictors of Success for the North American Pharmacist Licensure Examination. *Am J Pharm Educ*. Nov 2021;85(10):8591. doi:10.5688/ajpe8591
6. NABP Staff. Falling test scores: Covid-19 is just one reason. NABP Blog. National Association of Boards of Pharmacy. February 15, 2023. Accessed March 12, 2024. <https://nabp.pharmacy/news/blog/test-scores-have-been-falling-covid-19-is-just-one-reason/#:~:text=A%20temporary%20decline%20in%20exam,25%20questions%20over%20six%20hours>.
7. Ta A, Neumiller JJ, Kim AP, Remsburg CM, Gothard MD. The Effect of Pharmacy Students' Attendance on Examination Performance in Two Sequential Active-Learning Pharmacotherapy Courses. *Am J Pharm Educ*. Sep 2020;84(9):ajpe7749. doi:10.5688/ajpe7749
8. Page MJ, McKenzie JE, Bossuyt PM, et al. The Prisma 2020 statement: An updated guideline for reporting systematic reviews. *Systematic Reviews*. 2021;10(1). doi:10.1186/s13643-021-01626-4
9. Rose E, Claudius I, Tabatabai R, Kearl L, Behar S, Jhun P. The Flipped Classroom in Emergency Medicine Using Online Videos with Interpolated Questions. *J Emerg Med*. 2016;51(3):284-291.e1. doi:10.1016/j.jemermed.2016.05.033
10. Aksoy B, Pasli Gurdogan E. Examining effects of the flipped classroom approach on motivation, learning strategies, urinary system knowledge, and urinary catheterization skills of first-year nursing students. *Jpn J Nurs Sci*. 2022;19(2):e12469. doi:10.1111/jjns.12469
11. Riddell J, Jhun P, Fung CC, et al. Does the Flipped Classroom Improve Learning in Graduate Medical Education?. *J Grad Med Educ*. 2017;9(4):491-496. doi:10.4300/JGME-D-16-00817.1
12. Ji M, Luo Z, Feng D, Xiang Y, Xu J. Short- and Long-Term Influences of Flipped Classroom Teaching in Physiology Course on Medical Students' Learning Effectiveness. *Front Public Health*. 2022;10:835810. Published 2022 Mar 28. doi:10.3389/fpubh.2022.835810
13. Elledge R, Houlton S, Hackett S, Evans MJ. "Flipped classrooms" in training in maxillofacial surgery: preparation before the traditional didactic lecture?. *Br J Oral Maxillofac Surg*. 2018;56(5):384-387. doi:10.1016/j.bjoms.2018.04.006
14. Blanic A, Sholeh C, Marquion F, Benhamou D. Comparison of multimodal active learning and single-modality procedural simulation for central venous catheter insertion for incoming residents in anesthesiology: a prospective and randomized study. *BMC Med Educ*. 2022;22(1):357. Published 2022 May 11. doi:10.1186/s12909-022-03437-0
15. Beom JH, Kim JH, Chung HS, Kim SM, Ko DR, Cho J. Flipped-classroom training in advanced cardiopulmonary life support. *PLoS One*. 2018;13(9):e0203114. Published 2018 Sep 5. doi:10.1371/journal.pone.0203114
16. Bergmans E, Billington A, Thies KC. From tradition to innovation: a comparison of the traditional 4-step approach versus a blended learning modification for technical skills teaching. *Scand J Trauma Resusc Emerg Med*. 2023;31(1):80. Published 2023 Nov 14. doi:10.1186/s13049-023-01127-4
17. Lu RY, Yanovich T, Enyedi L, et al. The flipped-classroom approach to teaching horizontal strabismus in ophthalmology residency: a multicentered randomized controlled study. *J AAPOS*. 2021;25(3):137.e1-137.e6. doi:10.1016/j.jaapos.2021.01.008
18. Dombrowski T, Wrobel C, Dazert S, Volkenstein S. Flipped classroom frameworks improve efficacy in undergraduate practical courses - a quasi-randomized pilot study in otorhinolaryngology. *BMC Med Educ*. 2018;18(1):294. Published 2018 Dec 4. doi:10.1186/s12909-018-1398-5
19. Malik SS, Yasmeen R, Khan RA. A Randomized controlled study to evaluate the effect of flipped classroom relative to a traditional demonstration method on learning of procedural skills in dermatology residents. *J Pak Med Assoc*. 2020;70(9):1547-1553. doi:10.5455/JPMA.27173
20. Hoover CA, Dimdorf-Hogenson GA, Peterson JL, Tollefson BR, Berndt JL, Laudenbach N. Flipped Classroom: Do Students Perceive Readiness for Advanced Discussion?. *J Nurs Educ*. 2018;57(3):163-165. doi:10.3928/01484834-20180221-07
21. He Y, Lu J, Huang H, et al. The effects of flipped classrooms on undergraduate pharmaceutical marketing learning: A clustered randomized controlled study. *PLoS One*. 2019;14(4):e0214624. Published 2019 Apr 10. doi:10.1371/journal.pone.0214624
22. Wu YY, Liu S, Man Q, et al. Application and Evaluation of the Flipped Classroom Based on Micro-Video Class in Pharmacology Teaching. *Front Public Health*. 2022;10:838900. Published 2022 Mar 24. doi:10.3389/fpubh.2022.838900
23. Lu C, Xu J, Cao Y, et al. Examining the effects of student-centered flipped classroom in physiology education. *BMC Med Educ*. 2023;23(1):233. Published 2023 Apr 12. doi:10.1186/s12909-023-04166-8
24. Shuai L, Huiwen W, Shihao D, Li J. The application of flipped classroom combined with team-based learning in the orthopedic clinical teaching. *Medicine (Baltimore)*. 2023;102(43):e35803. doi:10.1097/MD.00000000000035803