

## REVIEW

# The Flipped Classroom – From Theory to Practice in Health Professional Education

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The flipped classroom is growing in popularity in health professional education. As such, instructors are experiencing various growing pains in functionalizing this model, from justifying the approach to managing time inside and outside of class to assessing impact on learning. This review focuses on some key theories that support the flipped model and translates those key theories into practice across core aspects of the flipped classroom: pre-class preparation, in-class activities, after-class activities and assessment of student learning.

**Keywords:** metacognition, critical thinking, active learning, flipped classroom, assessment

## INTRODUCTION

Flipping the classroom represents an ongoing paradigmatic shift in education from teacher-centered instructional strategies (eg, lecturing) to learning-centered instructional strategies (eg, active student engagement). The flipped classroom (also called reverse, inverse, or backwards classroom) is a pedagogical approach in which basic concepts are provided to students for pre-class learning so that class time can apply and build upon those basic concepts.<sup>1</sup>

While the term “flipped classroom” has garnered considerable attention in recent years, learner-centered pedagogies that effectively engage students in the learning process have a long and rich history. Approaches such as problem-based learning (PBL) and case-based learning (CBL) reflect many of the same learning-centered principles as flipped learning. Within PBL and CBL, students apply a specific problem-solving process using real-world problems or case narratives to acquire new knowledge.<sup>2</sup> This process may or may not require pre-class learning. However, the flipped classroom may vary from PBL or CBL in the level of guidance provided by an instructor and the types of activities used to facilitate learning, according to the following key flipped classroom elements: pre-class offloaded content, described as the process of packaging and delivering key foundational content to students prior to class; in-class active learning, represented by a wide range of well-developed and

evidence-based, active-learning strategies; assessment, including diverse approaches to evaluating and providing feedback to student learning and holding students accountable for learning pre-class and in-class material; and exploration, characterized by student-initiated inquiry.<sup>1,3,4</sup>

A growing body of research in pharmacy education describes various strategies for offloading content, designing active learning, and assessing student outcomes in the flipped classroom.<sup>5-9</sup> Additional flipped approaches are described across a wide range of disciplines, including medicine, economics, and physics.<sup>10,11</sup> While technology is not required, it is commonly used to deliver pre-class learning materials to students (eg, captured video lectures, podcasts, web-based modules, and animated e-books). However, static materials such as traditional texts, articles or websites also can be effective tools for class preparation.

In the digital age, learners are able to independently access more content than ever before, making learning (or self-regulated learning) and the placement of information critical to promoting learning outcomes. By blending the strengths of computer-mediated instruction (eg, digital interfaces, self-paced learning, online engagement) and face-to-face class time (eg, collaborative opportunities, applied problem-solving, instructor and peer engagement), the flipped classroom can effectively improve student outcomes, increase student engagement, and enhance critical thinking development.<sup>12-15</sup> Providing students with key foundational content prior to class enables students to engage with content at their own pace, controlling when and how much content they view. When designed effectively, this pre-class work provides the

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foundation for in-class applied learning, which is then reinforced through after-class work and exploration.

Evidence and research aimed specifically at developing guidelines for flipping the classroom continue to emerge.<sup>16</sup> The purpose of the review is to explore best practices for designing flipped classrooms, presented in the context of educational theory and using evidence-based practice.

### **Evidence-Based Design and Recommendations**

***Theoretical Frameworks.*** The flipped classroom requires a systematic and evidence-based approach to designing instruction, starting with a clear definition of learning objectives and ensuring that all activities are aligned to achieve the desired objectives. The idea of instructional alignment was described by Cohen in the 1980s,<sup>17</sup> and then further developed by Biggs as an application of constructivist learning theory to instructional design.<sup>18,19</sup> Constructive alignment provides a framework for designing and implementing a course or lesson to support high-level learning objectives;<sup>18</sup> this alignment begins with the objectives (ie, what students should be able to do or know as a result of this course). Once the objectives are set, assessments should be designed to monitor student learning and determine the extent to which students achieved or are achieving the objectives. Activities for in-class, pre-class, and post-class learning should then be determined and designed to facilitate progress toward desired objectives. Alignment principles can be found in a number of course design models and taxonomies, including Fink's (2003) integrated course design, which proposes assessment of course content and higher-ordering thinking in six taxa: foundational knowledge, application, integration, human dimension, caring, and learning how to learn.<sup>20</sup>

While constructive alignment will inform the synchronicity of the goals of course materials and activities, successful flipped design may require a more nuanced understanding of educational theories that elucidate how and why students learn. A wide range of learning theories and educational models can be used to specifically design, operationalize, and evaluate a flipped classroom, including but not limited to constructivism,<sup>21</sup> connectivism,<sup>22,23</sup> and andragogy.<sup>24</sup> In the interest of space and time, three salient and widely cited models directly related to course design are described below: mastery learning, deliberative practice, and cognitive apprenticeship.

Mastery learning was first suggested by Benjamin Bloom<sup>25</sup> and is an approach to competency-based education that can promote long-term retention and transfer of knowledge and skills.<sup>26</sup> The activities used in mastery

should transfer to practice, whether that is clinical practice, scholarly inquiry, or other pharmacy or health professional relevant skills. Transfer to practice demonstrates that skills acquired in the flipped classroom generalize to real clinical settings. The seven features of mastery learning include:<sup>26</sup> baseline testing; clear learning objectives, sequenced as units ordered by increasing difficulty; engagement in educational activities (eg, skills practice, data interpretation, reading) that are focused on reaching the objectives; establishment of a minimum passing standard (eg, test score, checklist score) for each educational unit; formative assessment to gauge unit completion at a preset minimum passing mastery standard; advancement to the next educational unit given measured achievement at or above the mastery standard; or continued practice or study on an educational unit until the mastery standard is reached.

Deliberative practice is defined as engaging in structured activities created specifically to improve performance in a domain. Certain criteria must be met for deliberate practice to be effective. Borrowing from the simulation literature, these factors include: highly motivated learners with good concentration (eg, student-pharmacists); engagement with a well-defined learning objective or task, at an appropriate level of difficulty, with; focused, repetitive practice, that leads to; rigorous, precise measurements, that yield; informative feedback from educational sources (eg, instructors, activities), and where; trainees also monitor their learning experiences and correct strategies, errors and levels of understanding, engage in more deliberate practice and continue with; evaluation to reach a mastery standard, and then advance to another task or unit.<sup>26</sup>

Cognitive apprenticeship is a collection of pedagogical principles aimed at providing students with learning experiences that expose the nature of expert practice and the cognitive processes of a skilled practitioner.<sup>27</sup> Cognitive apprenticeship assumes that implicit processes involved in complex skill development may be overlooked by instructors and asserts that learning experiences should be designed to unmask these processes so that students can observe and apply them with instructor oversight.<sup>27</sup> As a result, this theory promotes learning activities and assessments that allow students to better understand and modify their own thinking processes to more closely resemble expert thinking. Classroom design that supports cognitive apprenticeship should consider the four dimensions that constitute any learning environment: types of knowledge required for expertise (content): domain knowledge, heuristic strategies, control strategies, and learning strategies; ways to promote development of expertise (methods): modeling, coaching,

scaffolding, articulation, reflection, and exploration; keys to ordering learning activities (sequencing): increasing complexity, increasing diversity, and global to local skills; and social characteristics of learning environments (sociology): situated learning, community of practice, intrinsic motivation, and cooperation.

While these theory-based approaches to designing and operationalizing the flipped classroom vary, they all incorporate the use of progressive problem-solving that engages learners in increasingly complex problems. This approach is critical to the development of expertise<sup>28,29</sup> and is easily accommodated by the flipped classroom. Increased complexity can be achieved with simpler tasks shifted to pre-class study and class time dedicated to more complex tasks through applied active learning. Incorporating sequencing and scaffolding principles also can help bridge the gap between pre-class learning (eg, acquisition of foundational knowledge) and in-class learning (eg, development of strategic knowledge). Further, various in-class active learning strategies can support learners as they move to more complex problem-solving during class time.<sup>30</sup>

In addition to these design-based theories, it may be useful to consider a theoretical framework aimed at understanding human behavior within the context of the flipped classroom. Self-determination theory (SDT) reflects human motivation and our inherent growth tendencies and innate psychological needs. SDT identifies autonomy (or freedom of choice), relatedness, and self-efficacy/competence as the three innate needs for intrinsic motivation.<sup>5</sup> By design, the flipped classroom can facilitate student motivation in a number of ways, including but not limited to: allowing students to learn material on their own time at their own pace before class (autonomy); providing flexibility for due dates or choice of practice activities (autonomy); using active learning that requires in-class discussions with peers (relatedness); incorporating practice activities related to future applications of clinical practice (relatedness); embedding self-assessments that enable students to determine their own strengths and weakness (competence); and administering assessments that allow students to demonstrate progress toward achievement of desired outcomes (competence).

Throughout this design process, course alignment should be revisited to ensure that the content, materials, activities, and assessments are positioned to optimize student learning. For example, if the goal of a lesson is to foster critical thinking skills, but in-class time is dedicated to passive instruction (ie, the instructor lectures), it is unlikely that students will develop the intended skills because lecturing is misaligned with critical thinking.<sup>31-35</sup> Informing classroom design with theory-based

educational principles can further ensure that assignments and activities are educationally purposeful, timely, and motivating for students. The remaining sections provide recommendations for designing and implementing a flipped classroom, informed by the literature and the evidence-based theories described above. They are organized as follows: course objectives; pre-class assignments; in-class activities; after-class work; and assessments. Each of these factors can be adopted in isolation of the others as part of general course improvement but the flipped classroom is more than the sum of its parts. The alignment and integration of these factors can lead to higher functioning courses because of the synergy gained.

**Course Objectives.** Course objectives communicate expectations to students and guide the design of the class. Objectives need to be high but achievable to achieve optimal motivation and, per the SMART acronym, should be specific, measurable, actionable, relevant and timely.<sup>36,37</sup> “High” means challenging and is a relative term that is dependent on the learners’ knowledge or skill state (ie, where they are vs where they need to be) and can be reflective of higher order learning (eg, upper level of Bloom’s Cognitive Taxonomy), competency level (eg, must achieve 85% correct on multiple occasions), skill or attitude level, or depth or breadth of processing. For relevancy, objectives should be framed to pharmacy practice – even it is foundational science (ie, a patient at the end of every lesson). Students need to see the relevance of what they are learning because the goal is to develop skills within courses that transfer to real-world settings, and relevancy is critical to motivation. Further, given the growing need for professional development amid a rapidly evolving health care system, these objectives should extend beyond content knowledge to address contemporary workforce skills, such as teamwork, problem-solving, communication skills, adaptability, and learning how to learn.

**Pre-class Assignments.** In the flipped classroom, students must obtain foundational material outside of class as preparation for in-class activities. Within the literature, this has been referred to as self-paced learning, self-directed learning and, sometimes, self-regulated learning. Self-paced learning generally refers to the learners controlling their study time compared to time controlled by an outside influence (eg, instructor).<sup>38</sup> Self-directed learning can be defined as allowing learners to make decisions about the information they want to experience. Although information selection is generally governed by the instructor and limited in scope, learners can choose to respond to different cues of the environment<sup>39</sup> and actively evaluate what has been said and what other information is

required.<sup>40</sup> Self-regulated learning refers to processes that enable individuals to guide their goal-directed learning activities over time. It maximizes the long-term best interest of an individual and allows the learner to develop self-regulated behaviors (eg, planning, monitoring, metacognition, attention) to control what and how much is learned.<sup>38,41-44</sup> Learners regulate the amount of effort devoted to learning by monitoring behavior and feedback on their performance.<sup>43</sup> Taken together, these learning theories suggest that pre-class learning activities must have clear goals, allow for self-pacing to optimize attention and effort, and provide self-assessment to help students monitor learning gains.

A growing body of evidence suggests that students can effectively learn material on their own through a variety of modalities.<sup>7,8,13,45</sup> Bligh<sup>33</sup> summarizes studies that compared various instructional approaches to lecture for the acquisition of knowledge and described a self-directed approach, termed personalized system of instruction (PSI), as effective. Murad<sup>46</sup> performed a meta-analysis on self-directed learning on acquiring knowledge and found a moderate effect size of 0.4, indicating that the average students learning in a self-directed environment perform 0.4 standard deviations above the control (lecture or instructor-controlled environment). This translates to a moderate effect size suggesting self-paced learning has a practical significance beyond the effects of lecture in helping in the acquisition of knowledge. In addition to learning more, self-paced instruction may increase efficiency up to 30%; that is, students can learn material one-third faster in a self-paced environment than an instructor-controlled environment.<sup>47,48</sup> Some of the modalities that have been used for pre-class learning include:

commercial textbooks, instructor-developed reading material, instructor-developed videos (eg, narrated PowerPoint, lecture capture), or animations.<sup>7,9,13,15,45,49-52</sup> As examples, Dupuis and Persky used a variety of formats when transitioning to a flipped model, and students indicated that annotated PowerPoint slides were their preferred resources, followed by commercial textbook readings with guided questions and narrated PowerPoint presentations.<sup>45</sup> However, Wong and colleagues used narrated PowerPoints for pre-class learning, and 39% of students favored this mode because of its navigation and use.<sup>50</sup>

Because the flipped classroom model relies on active engagement during class that extends concepts learned before class, student preparedness for class cannot be overstated. Table 1 provides evidence-based tips for designing and developing pre-class video or reading material. Most notably, the following theory-based tips may motivate students to complete pre-class learning: Help students plan out-of-class learning by being transparent about expectations, objectives, and resources; provide embedded self-assessment questions or study guide questions that enable students to assess mastery; use relevant examples, pictures, or videos to help focus student attention;<sup>53</sup> and hold students accountable for learning. Assessments for accountability are described in more detail in later sections.

In addition, a common challenge in the design and delivery of pre-class learning is recognizing student time required to complete pre-class activities. Textbooks are written by experts for experts and may be written above the comprehension level of the student. As an example, Fuller and colleagues<sup>54</sup> found that the reading level of the

Table 1. Evidence-based Tips for Developing Video or Reading Material<sup>83-90</sup>

<b>Tips for Video</b>	<b>Tips for Reading Material</b>
Divide longer lectures into 3- to 12-minute segments for recording. This will make the material more accessible to students, as well as help prioritize and organize the topics for the students.	Images + adjacent text is better for retention and learning
Use a more informal tone to make the listening experience more personal for students.	Have students answer guided questions PRIOR to reading
Post note sets that correspond to the lecture so that students can fill in missing information in their own notes. This can also give students an alternative to watching videos.	Keep the language simple and cohesive
Combine pictures, graphs or figures with narrated explanations. Avoid non-essential pictures or animation or text on screen with narrated text.	Focus on important points, avoid extraneous information
Have user controls to rewind, fast forward or slow/accelerate the speed of the video	Use bullet points when appropriate. They are remembered better
	Avoid things that may draw attention away from the main text (eg, side bars or hyperlinks)
	Teach them reading techniques like SQ4R (survey, question, read, write, recite) <sup>90</sup>



standard pharmacy textbook or treatment guidelines was three grade levels higher than their ability. If students have difficulty understanding the jargon or language of the discipline, they may lose motivation (relatedness, competence).

Since students must come to class with foundational content to engage, pre-class material should enable students to learn efficiently and effectively. As a general rule of thumb, a 1:2 ratio for in-class to out-of-class time can be used to minimize excessive stress and is in line with the some studies of flipped courses.<sup>13,15,51,52</sup> This ratio assumes a 15-17 hour credit load, and we estimate students may only have up to 35 hours a week to study and prepare for courses based number of hours students spend on activities of daily living (eg, eating, traveling to school), sleeping, in-class and co-curricular activities.<sup>55</sup> Since out-of-class time may include studying and completing homework, thoughtful consideration should be given to how much time is expected for students to prepare for class (eg, three hours of in-class time per week means six hours a week preparing for class, completing homework, and studying for exams). Table 2 provides estimates for the amount of time students might spend reading and watching videos when learning new material. For example, a scholarly article of 3000 words takes approximately 15 minutes to read, and a book chapter of 10,000 words takes approximately 50 minutes to read. If that 3000 word count is part of a script for a narrated video, the video will be at least 30 minutes long. Based on conversions in Table 2, this means that a 3000 word article requires approximately 45 to 60 minutes of reading and studying, the 3000 word narrated video takes 90 to 150 minutes to watch and study, and the 10,000 word chapter demands about three hours to read and study. In addition, learners may take an estimated two to five times longer than a faculty member to complete a given task, depending on the task, and this is consistent with differences between experts and novices.<sup>56-65</sup>

To summarize, evidence suggests students can learn foundational content (ie, definitions and concepts) on their own before class and that student engagement may be encouraged when the instructor communicates expectations, uses accountability for preparation, provides engaging and interactive activities, and ensures the material is student-friendly and efficient.

**In-class Activities.** Once students have a foundational knowledge of key definitions and concepts, class time can be used to reinforce and extend learning through application and problem-solving. A growing body of evidence demonstrates the effectiveness of active-learning.<sup>30</sup> In general, evidence suggests that well-designed active learning can foster higher-order thinking skills, collaborative skills, and self-awareness.<sup>66</sup> A wide range of active learning exercises are described in the literature and selecting or designing an activity for the flipped classroom should be guided by its alignment with pre-class learning and the course objectives, as described by constructive alignment.<sup>18</sup> Communicating explicit links between pre-class learning and in-class activities can help students appreciate the importance of learning foundations before class and the importance of extending those basic concepts to think deeply and critically about a problem or challenge. In addition, using real world examples and challenges can further illustrate the relevance of the pre- and in-class activities. These real world problems should provide student opportunities to practice and assess mastery or proficiency during class, particularly for the development of higher order thinking skills. Some common examples include case vignettes, higher order think-pair shares, student or student group presentations or role play involving patient – pharmacist interaction.<sup>13,45,49-51,67</sup>

Students may need scaffolding or support intellectually to transition from simple concepts learned prior to class toward complex ideas and application during class. As experts, instructors will play a critical role during class by helping students make sense of the material,

Table 2. Average Times of Reading and Listening and Conversion to Student Study Time<sup>56-59</sup>

Action	Range	Notes
Average Student Reading speed (words per minute)	150-400 words per minute	Expect reading speeds to be higher for material requiring less cognitive loads (~400 words per minute)
Average Student Listening speed (words per minute)	110-190 words per minute	Use slower speaking speeds to promote better cognitive processing.
Ratio of reading / listening to study time	1:(3-5)	Expect students to spent 3 to 5 times longer studying the material than the estimated time to read it or watch it.

responding to questions, and providing feedback concerning progress (eg, clicker questions). This may require iterative processes that enable students to develop, test, and correct their own ideas and answers based on frequent instructor or peer feedback. This is best accomplished when instructors are trained in facilitation skills. Strategies for instructor development may include workshops, one-on-one meetings with experts, or texts that provide support for the development of instructional and interpersonal skills, flipped pedagogy, writing higher level learning outcomes, and course design.

Of note, instructors should adhere to the flipped model during class. Double lecturing, which occurs when pre-class material is re-lectured during class or new material is lectured, limits opportunities for student engagement and directly contradicts the flipped model. While a “time for telling” (eg, micro or mini lectures) may be necessary to explain complex concepts or clarify misconceptions, long and passive lecturing should be minimized. If class time is redundant and repetitive of pre-class learning, there is very little incentive for students to prepare for or attend class.

**After-Class Work.** The majority of flipped classroom discussion and research has focused on pre-class and in-class activities. However, it is important to remember that learning does not stop after the class session ends and that learning is optimized with ongoing practice. After-class work that is aligned with course objectives can support self-determination and promote intrinsic motivation. Instructors can optimize motivation by having flexible learning opportunities either with timing of when practice assignments are due or choice of practice activities. These assignments can extend the relevance of what they are learning and should provide feedback they are moving towards proficiency within the course goals. Further, after-class work should provide feedback to students on areas of strength and improvement and opportunities for more practice.

Complexity, spacing, and time constraints are critical design components for after-class work. Starting with simpler or more straightforward practice and building complexity over time can help with developing mastery. Focused, repetitive practice can also facilitate transfer of learning, which is the process of solving new problems in the same topic (eg, dosing aminoglycosides in two patients with different indications), the same problem in a different topic domain (eg, adjusting therapy for two patients on different drugs), or both.<sup>68</sup> After-class work should be diverse enough to help students generalize their skills sets and transfer them to other problems and courses. With regards to spacing, individuals who mass their practice (practice all at once)

perform poorer on later assessments than individuals who space their practice (practice over time).<sup>69,70</sup> Other criteria also influence retrieval of knowledge and skills (see <sup>71</sup>), and consideration should be given to recommendations and requirements for after-class practice. For a 1:2 ratio for in-class to out-of-class, and an estimated 0.75 to 1.0 hours of pre-class work for every hour in class, there is approximately 1 hour of out of-class time remaining. First, we must remember studying (eg, reviewing, practice texting, transcribing notes) is a time-consuming behavior. We can reduce pre-exam study time immediately proximal to an exam because of the time spent learning during pre-class work and in-class activities. Spending sufficient time practicing is important, but we have to be selective in our exercises because time is limited. Based on differences between experts and novices and the impact of practice on speed, we may assume it takes students at least 1.5 (maybe up to 5) times longer to complete a practice problem as it would take an instructor (or expert).<sup>56-65</sup> Therefore, if you design out-of-class cases that might take you 15 minutes to answer, that could be 60 minutes for the student.

Typically, after-class work is used to reinforce the prior learning in a structured way through additional programs that helps student practice near (problems close in structure to the original) or far transfer (problems more dissimilar to the original) conditions.<sup>68</sup> Other options can include more inquiry-based approaches (eg, problem-based learning) or self-directed activities – both of which can help students explore aspects of the content beyond the scope of the class.<sup>40,46,72,73</sup> These exploration activities may be more instructor-driven as in the case with more inquiry-based models where the instructor gives more robust cases to be explored or student-driven, as in the case with SDL because students are identifying their learning goals.

### **Assessment**

Within the context of the flipped classroom, faculty may need to rethink traditional approaches to learning assessment. Aligning assessment strategies with pre- and in-class learning objectives and activities is critical for optimizing student outcomes. An emerging guideline for flipped learning suggests that assessment should be used to hold students accountable for pre-class learning (Table 3).<sup>10,74-76</sup> In lecture-based courses, students have traditionally been asked to prepare for class, but success in the flipped class hinges on pre-class preparation because it is required for applied learning during class. Lack of student preparation can severely limit the efficacy of the

Table 3. Common Assessment Approaches in the Flipped Classroom. Most Activities Can Be Completed Individually, in Pairs or Small Groups<sup>10,74,75,78</sup>

	Format		Location		Grading			
					For Accuracy	For Completion	At Random (for Accuracy or Completion)	
	Computer-based	Pen & Paper	Pre-class	In Class				
Quizzes	X	X	X	X	X	X	X	X
Cases	X	X	X	X	X	X	X	X
Clickers/Audience Response	X			X	X	X		
Guided questions for pre-class material	X	X	X	X	X	X		X
Exams	X	X		X	X			
Projects	X		X	X	X	X		

flipped classroom, and assessment can be used as a mechanism for encouraging students to learn foundational material prior to coming to class. An additional benefit to frequent low-stakes assessments of student understanding (ie, retrieval or testing effects)<sup>77</sup> is it allows instructors to keep abreast of what concepts or skills are particularly challenging for students to master.<sup>78</sup> However, it is important to consider the frequency of quizzes within a single course and within a given semester as quizzes can alter motivation (to focus more on grades) and can take away from time on other class activities.<sup>79,80</sup>

Various formative and summative assessment methods can be used to provide feedback to faculty and students. Assessments can be used during interaction with peers, instructors, and other educationally relevant people (eg, standardized patients), for example, as a means of demonstrating competence and enabling self-assessment of mastery. In addition, self-assessments embedded within pre-class online learning modules can help students gauge mastery of content prior to class. Active learning exercises can be designed to provide real-time formative assessments to students and immediate feedback to faculty concerning misconceptions or gaps in student knowledge (eg, minute paper, muddiest point). The flipped classroom is designed to develop higher order thinking in students<sup>81</sup> and, as such, graded assessments should provide students the opportunity to demonstrate the development of these skills (eg, open text, essay, papers, etc).

The type and weight of an assessment can significantly impact how students learn because assessments often signal to students what is important in the class. Student assessment should be tied to course objectives and key principles, and provide feedback to instructors and students. It may be worth noting that traditional

methods such as paper and pen exams may not effectively reflect achievement of all learning goals. For example, communication skills or teamwork cannot be fully assessed in a paper and pen exam and, therefore, other approaches are required that are clearly matched to learning goals. Instructors should clearly communicate expectations and specify how the assessment will be evaluated at the time it is assigned. Regardless of format, assessments should enable students to demonstrate meaningful understanding and application of essential knowledge and skills.

Redesigning learning environments is a complex undertaking that often takes multiple iterations of implementation and refinement to achieve desired outcomes. When used correctly, assessments can provide: feedback about student learning and instructional design; and ongoing quality improvement feedback for the iterative process of course development. Thoughtful consideration should be given to collecting, analyzing, and using data to select relevant content, inform instructional design, manage classroom activities, and improve student learning.

**Time for development**

As others consider implementing the flipped classroom, a final recommendation is to consider the time and resources required for flipping. From a student perspective, the time required to learn in the flipped classroom is not trivial and should be managed carefully. We estimate a ratio of 0.75:1.0 to 1.0:0.5 for pre-class to in-class to directed post-class activities (Table 4). Thus, for a 3-hour credit course in a 15-week semester, that is <3 hours a week of pre-class preparation, 3 hours of in-class activities, 1.5 hours of after-class practice and 1.5 hours of study for a total of 1:2 in-class to out-of-class time.

Table 4. Summary of Recommendations, Including Proposed Time Allocation Ratios, for the Flipped Classroom. (Derived from literature citation in this paper)

<b>Course Section</b>	<b>Proposed Time Ratio Allocation</b>	<b>Recommendation</b>
Course Objectives	—	Course objectives should focus on higher order thinking (eg, Bloom’s Cognitive Taxonomy of application and above) and include skills such as critical thinking, communication, and teamwork. These objectives should be aligned with real-world pharmacy situations.
Pre-class Activity (can include assessments)	0.5-1.0 (eg, 1.5 to 3 hours per week for 3 credit course)	Pre-class materials should orient student to foundational definitions and concepts that will be built upon during class. This material should be direct, relevant, efficient, experience-level appropriate (eg, novice, advanced beginner), accountability-driven, and provided to students well in advance of the due date.
In-class Activity (can include assessments)	1.0 (eg, 3 hours per week for 3 credit course)	Class time should emphasize active engagement through structured activities guided or facilitated by the instructor. The instructor should provide support for activities that extend pre-class learning to apply concepts, solve complex problems, interpret information, or otherwise engage in real-life practices that develop higher-order skills.
After-class Activity (can include assessments)	0.25-0.5 (instructor directed) 0.5-0.75 (student-directed) (eg, 1.5 to 3 hours per week for a 3-credit course)	After-class work should reinforce the course objectives and be increasing in complexity and integration of material. Topics should be relevant to future course work, spaced appropriately, and diverse in nature to increase transferability.
Assessment	Included in ratios above	Assessments should be designed to fully reflect the depth and breadth of learning in the flipped classroom. Diverse approaches should be used in an effort to provide formative and summative feedback to students and faculty regarding progress toward achieving course learning objectives.
Overall Course	1(in-class learning):2 (out-of-class learning) (eg, 6 hours of out-of-class work for 3 hours of in-class work for 3 credit course)	Course objectives, pre-class and in-class activities and assessments should be designed according to sound instructional alignment principles. Resources (eg, time, personnel, training) should be identified and secured prior to implementation of the flipped model. Consideration should be given to how the course and its requirements fit into the larger curriculum and co-curriculum.

From a faculty perspective, the flipped classroom can take a significant amount of time and energy to develop initially. McLaughlin and colleagues<sup>13</sup> reported an additional 127% of time to redesign and implement a basic pharmaceuticals course into a flipped classroom (from 250 hours for a lecture-based course to 567 hours for the first iteration of the flipped course). Appropriate faculty support and development could help institutions fully

realize the potential of engaged classrooms. Further, having access to experts in instructional design, active learning, assessment and cognitive or educational psychology could further advance flipped models.<sup>82</sup> Aligning promotion and tenure policies with pedagogical innovation also may incentivize faculty engagement in the flipped model. Before implementing a flipped classroom, faculty should ensure that technological support for



the development and management of material and within classrooms is available and accessible.

## CONCLUSION

The flipped classroom has garnered significant attention in recent years and represents a growing shift from teacher-centered to learning-centered instructional strategies. This pedagogical approach is a highly translatable and flexible model characterized by a wide range of approaches to pre-class assignments, in-class activities, after-class practice, and assessments. Moving foundational course content outside of class protects instructor-student contact time for higher level learning – learning that cannot simply happen by reading a book.

The flipped classroom represents an important and exciting advancement in health professions education. However, whether flipped classrooms will become a dominant paradigm in pharmacy education over the coming decades remains to be seen. Further development and evaluation of flipped models is crucial for optimizing outcomes and ensuring that the model remains flexible, transferable, and relevant. Research concerning cost-effectiveness, non-cognitive skill development (eg, teamwork, empathy, communication, adaptability), optimal strategies and modalities, learning space design, long-term impact, and faculty development could help further advance the impact and effectiveness of the flipped classroom.

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