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Short Communication

The flipped classroom in medical education: A new standard in teaching

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ABSTRACT

Many medical educators, out of necessity imposed by the COVID-19 pandemic, had to flip their classrooms. However, instead of adapting to this new teaching style, many have proceeded in the manner that they have always used to create content, opening a slide deck and inserting content until they are satisfied with the result. When in fact, we know based on evidence and our own experience, that educators should first plan, organize, and storyboard before collecting information into a presentation [1,2].

If educators need to replace real-world teaching and interaction, we believe the next best option is video education, although there are other forms of prework that can be utilized to flip medical classrooms, including short readings and exercises. We discuss the case for flipping medical classrooms, the limitations, and how educators can get started flipping their classrooms today.

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1. Introduction

For hundreds of years, medical content has been delivered in a mostly traditional style, with an instructor lecturing and a learner passively taking in the information, to then be reviewed later when exams approach. What the flipped classroom model does is ask learners to switch the in-class and at-home activities of learning (see Table 1) by completing pre-class assignments, such as watching a short video, listening to a talk or podcast, or reading a journal article (self-learning the lecture or theory material) [1–3]. Then in-class time is used to work on cementing and creating connections to that knowledge through discussions, interactive exercises, group learning, and case studies [4].

As new schools are researching models for their curricula and established institutions are implementing changes that keep up with learner preferences, both in the digital age of learning and due to pressures imposed by the COVID-19 pandemic, the authors make the case for flipping classrooms in healthcare education and share where further evidence is warranted.

2. Benefits of the flipped classroom in medical education

2.1. Student satisfaction

One of the most well-studied benefits of the flipped classroom approach is increased learner satisfaction. Learners in flipped classrooms report increased satisfaction with the ability to access pre-class assignments and learn at their own pace as well as enjoy the greater focus on discussions and hands-on activities during class, when compared to traditional lecture formats [4–6]. As suggested by psychologists, two components are critical to help learners cope with the cognitive load associated with learning new material: self-pacing and tailoring the content to the learners' needs (see Fig. 1). In essence, flipped classroom models have been shown to allow students to customize their learning experience to reduce cognitive load, based on their level of understanding (tailoring to expertise); with high-achievers skipping the parts that they understand and lower achieving students having the ability to review content they are struggling with (self-pacing) [5–7]. Even in graduate medical education settings, where learners have less time to prepare before instructional activities, there was still an overall favorable impression of flipped classroom learning. A study by Chokshi et al. [8] showed that residents reported themselves as better teachers after learning in a flipped classroom setting, while Tainter et al. [9] reported increased confidence in residents performing ultrasound.

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Table 1
In the flipped classroom the knowledge transmission and application phases of learning are flipped [6].

	Knowledge transmission	Application and practice
Traditional classroom	Face-to-face (lecture)	Self-directed (homework)
Flipped classroom	Self-directed (prework)	Face-to-face (discussions/cases)

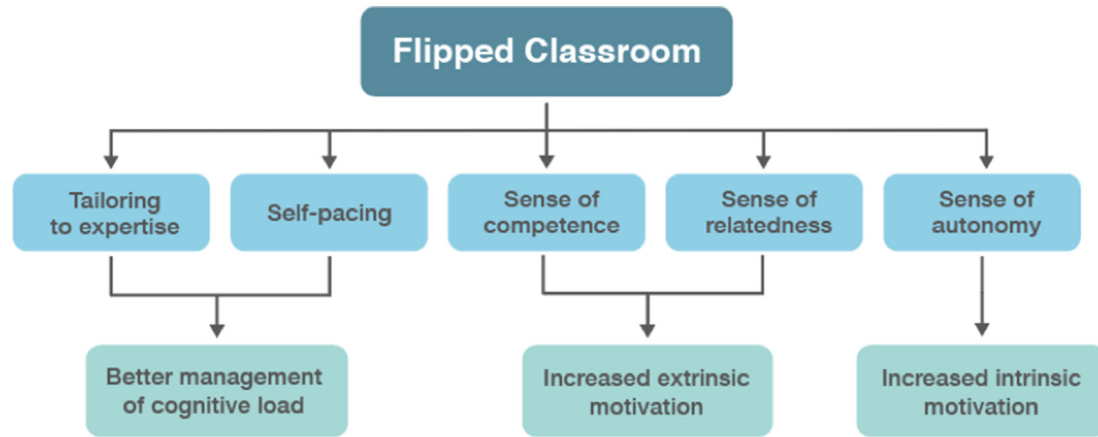


Fig. 1. Flipped classroom in management of cognitive load and motivation levels [7].

2.2. Learner motivation

Learner motivation is critical for the adoption of a flipped classroom model. In order for the flipped classroom to be effective, learners need to have either their own intrinsic motivation and sense of autonomy to complete assignments or extrinsic motivation gained from relating to peers and feeling competent (from performing well on quizzes or tasks related to their assignments). Psychologists suggest that a great flipped classroom model combines factors that build learner motivation both intrinsically and extrinsically [6,7]. The implementation of quizzes or other metrics, as part of the flipped classroom model, not only helps gauge student learning for instructional use, but also creates a sense of competence and serves to help prime the learner through knowledge recall [5]. Learners also report that quizzes administered prior to in-class activities increase their motivation to review the content prior to class [4,5]. JD Karpicke suggests that repeated retrieval practice, shortly after the initial learning period, followed by spaced repeated testing over time leads to better long term retention [10]. Larsen et al. found that initial testing on neurology topics with medical students enhanced their retention six months later [11]. Although test-enhanced learning has not been extensively studied in flipped classroom settings, retrieval during testing requires active processing and essentially practices the same skill needed later, which is more active than simply re-studying the material. Larsen et al. also suggests that frequent tests allow students to gauge their progress and for faculty to evaluate the effectiveness of a curriculum, to adjust it over time [11].

2.3. Learning benefits in procedures and higher processing

The data on the effects of flipped classrooms on the long-term retention of knowledge and changes in practice behaviors, related to the clinical setting, is mixed. However, current studies show that students are performing at least as well as those who attended traditional lectures, while some studies in select healthcare settings, show increased retention in flipped classroom settings [6,12]. Morton et al. suggested that the flipped classroom is best utilized to

teach higher-order skills or processing, such as analysis or application of knowledge versus simple memorization [13]. Instead of increasing the extraneous cognitive load on the student, the flipped classroom model optimizes the learners germane cognitive load, or their deep processing of new information and helps integrate it with existing knowledge [13].

For example, Lehmann et al. demonstrated superior procedural knowledge in pediatric residents utilizing a blended learning classroom with virtual or video content when compared to a control group who received instruction via traditional lecture and skills station teaching [14]. King et al. looked at determining whether flipped classrooms were utilizing higher processing through Kirkpatrick level classification; with changes in learner perception (Kirkpatrick level 1), change in opinion (Kirkpatrick level 2a), change in knowledge or skills (Kirkpatrick level 2b), or change in behaviors (Kirkpatrick level 3) due to flipped classroom learning [3]. As a result of flipped classrooms, further studies need to be conducted to assess long-term behavior change and practice patterns in medical settings (Kirkpatrick levels 3 and 4) [3]. However, based on evidence in small studies, internal medicine residents did increase their knowledge and self-reported changes in prescribing behaviors (Kirkpatrick levels 2 and 3) following a flipped classroom session that looked at pharmacotherapy in type 2 diabetes mellitus [15]. Many of these studies are preliminary and further research is needed to assess their widespread applicability but show promise particularly in procedural or skills areas. Where higher levels of processing are necessary, the flipped classroom may prove beneficial.

2.4. Faculty interest

Another benefit to switching to flipped classrooms is educator motivation and interest in switching up their teaching methods and learning new skills. In a study by Martinelli et al., when anesthesia faculty were surveyed regarding flipped classroom teaching, of the 244 respondents 57% expressed understanding of the flipped classroom technique, 32% had utilized flipped classrooms in the past year, but 89% desired further education on this topic [16].

There is faculty interest in learning new instructional methods and flipping medical classrooms if it will lead to better utilization of instructional time [3,16]. J. Moffett suggests that if educators are questioning whether they are best utilizing the time spent in front of their learners, transitioning to a flipped classroom or introducing some of its features could help reinvigorate a stale classroom [17].

3. Limitations of the flipped classroom in medical education

3.1. Lack of extensive knowledge retention studies

As with any novel approach there are a couple of arguments against flipping the classroom. One would be the time it takes to develop flipped classroom teaching materials, and another would be the lack of evidence that knowledge retention is superior in flipped classrooms over traditional classrooms. There is a paucity of large studies looking at long-term knowledge retention for learners in flipped classrooms over traditional classrooms. We do know that students often perform as well in flipped classrooms as in traditional lectures, are often more motivated, and perform better in select settings in smaller studies, but is that enough to suggest that flipping the curricula is what educators would deem *worth it?* [12].

Further studies need to be conducted ensuring we are adequately assessing knowledge retention, because certain procedural skills and higher-order processing may not always be well assessed using traditional (multiple choice) or current testing methods [11,18]. Part of the problem with many of the previously conducted studies, such as that by Riddell et al., in Graduate Medical Education is that they introduce a flipped classroom approach over a short period of time [19]. Flipping the medical classroom takes adjustment, and true differences cannot be assessed by flipping the classroom through recorded lecture provided over several days, without a period for learners to adjust to the prework involved in flipping of the classroom [19]. For most learners the flipped classroom is a new experience that differs from how they have ever learned or studied in the past.

3.2. Time investment

In terms of the time educators spend flipping medical curricula, it is not insignificant. McLaughlin et al. suggest that in order to successfully flip a classroom, an educator must invest 127% more time in course development and 57% more time to maintain that course than a traditional lecture [20]. However, Wagner et al. suggests, in congruence with the authors own experience, that once pre-class material is recorded or prepared, online courses and learning materials can be used on multiple, consecutive cohorts of learners, which frees up time for educators to focus their efforts on the hands-on aspects like bedside teaching, cases, and discussions [17,21]. According to Shimamoto and Snowden, *educator readiness is an important factor in the success of a flipped classroom course; if educators do not feel capable or enthusiastic to flip then it is unlikely to work* [17,22,23].

Similarly, the success of a flipped classroom model is dependent on learners coming to class adequately prepared, having already primed and familiarized themselves to the material provided to them, so that in-class time can best be utilized to cement that knowledge, make connections via cases and examples, and clarify any gaps in knowledge that still exist. Learners who preferred traditional lectures over flipped classrooms most often cited that the preparation time involved prior to attending class was burdensome [5]. Studies have shown that learners spend no more than about 20–30 minutes before class preparing and instructional videos ideally should not exceed 6 min in length [6,24,25]. It has, therefore, been suggested that the combined time for all videos and

prework should be formatted to fit within these learner preferences. [5].

3.3. Applicability to graduate medical education

Given that learner preparation time is a concern, it is unclear whether flipped classroom learning would be widely applicable to Graduate Medical Education. However, in a study by King et al., they found that flipped classroom learning had been implemented in over thirteen different residency program types, although the exact techniques utilized varied from program to program [3]. Due to the concern of limited time for residents to prepare for class it appears that many programs got creative with the prework provided [3]. Blair et al. suggests that preparation time may need to be included or planned into the didactic schedule for flipping medical classrooms in Graduate Medical Education [15].

4. Implementation of the flipped classroom model

4.1. Stepwise iterative approach

For universities and institutions who have been utilizing a traditional lecture format for many years, the idea of implementing a flipped classroom format may seem daunting. Curricular overhaul takes effort and adjustment from both educators and learners. Therefore, the authors suggest a stepwise, iterative approach, selectively flipping one class at a time, learning from the process, and then applying this newfound knowledge in flipping the next class. The following are suggested steps for implementing a flipped classroom model.

4.2. Determine the most suitable content

The current evidence suggests that the flipped classroom may be best utilized for teaching procedural or higher-level processing skills [13]. The authors agree that certain types of content are best suited for multimedia formats, such as skills-based teaching, whereas lists of symptoms may be best provided through a case example or reading. Look at the content currently taught and determine which may be best suited to flip first. Perhaps choose something like rapid sequence intubation, where a short step-by-step instructional video can be provided as prework. The skill can then either be practiced in class through simulation, or case-based scenarios asking the learner what the next step in their clinical reasoning or practice might be.

4.3. Student engagement

Explain the purpose and benefits of the flipped classroom format to your learners [26]. Without their enthusiasm and buy-in, the process is not likely to be a success, as student motivation and completion of prework are key. Also feel free to actively engage learners in their own curricular development and teaching [27]. Peer teaching can be an important skill to learn. Healthcare professionals are responsible for educating others in their field. Teaching skills can be developed during in-class time with fellow peers as learners.

4.4. Utilize materials that already exist

To begin, institutions can use video and other forms of prework that already exist, and integrate them within class discussions and cases. To get started, pulling material from either open-source content or paid platforms, may reduce the time burden on educators [17,26]. Viewing how other educators have created content

Table 2
Checklist for the best practices in flipped classroom learning.

Flipped Classroom Best Practices
Create/use short videos of <6 minutes in length [6].
Keep home-study material per class unit to ≤ 20 minutes [5,6,24].
Use metrics such as quizzes to assess student learning from videos and adjust in class activities as necessary [5].
Minimize the use of words on the screen (the audio is the text) [1,2].
Use simple images that clearly support what is being said [1,2].
Show images in coordination with the audio (no earlier and no later), [1,2]
Have a clear learning goal in mind when recording lessons. Instructional videos that stray away from their stated learning goal are a classic beginner's mistake. What is the one key take-away message? [1,2]
Video content should not stay static for >20 seconds. Things need to move and change on the screen for a video to be engaging [1,2].
Optimize use of in-class time via workshops or other problem/case-based activities that apply the knowledge the student has learned in pre-class materials [1,2].

may also spark some creative ideas for implementing certain teaching techniques into their own curriculum.

4.5. Keep it simple

Avoid the temptation to provide learners with too much pre-work or information [17,26]. Remember that one of the biggest barriers in a flipped classroom setting is student completion of prework and coming to class prepared to engage in activities. As previously mentioned, for best results, keep video materials to shorter than 6 min each (when possible) and all preparation materials to less than 20 minutes [6,24,25].

4.6. Adjust and tailor content

The key to successfully flipping the classroom is to provide learners with engaging content, such as short videos, case studies, interactive discussions, and quizzes right from the start. Assess student preferences and engagement with the various types of formats. Track their learning utilizing quizzes or other retrieval methods [17]. Then tailor the content to fit students' learning needs and preferences (including creating new original content as necessary). Once one workshop, course, or class has successfully been flipped, and learners are familiar with the concept and the pre-class workload necessary, other classes can be flipped—this time with more confidence.

4.7. Learn new techniques

Further classroom flipping may require instructors to record and post videos, create quizzes and handouts, or consider the implementation of other interactive learning exercises and cases.

In line with the authors' own experiences, studies have shown [25,28], some instructors struggle with recording their own short and engaging teaching videos that hold the learner's attention. Therefore, institutions interested in flipping the classroom should educate their instructors on teaching techniques for flipped classroom learning and the principles of effective video-based education if digital media is to be used for prework. Faculty are also students, learning new educational methods and need to be engaged. It is important that institutions provide them with engaging materials where they can refine and practice their skills in flipped classroom teaching. The authors have created a series of free teaching masterclasses to encourage educators to try new educational methods and get creative in their classrooms, like trying the flipped classroom approach [2]. The authors have put together a checklist for the creation of engaging educational videos, where educators can look at how to get started (see Table 2).

The future of medical education will continue to move in ways that embrace digital technology, as this is what *digital native* learners are increasingly expecting for their healthcare education

[29]. Already, learners are turning to open-source medical content that is available online. Institutions and learning platforms will best serve their learning communities by converting to a flipped classroom model that embraces this trend and the improved learning benefits it confers via more motivated and engaged learners [6]. More studies do need to be conducted to prove the long-term knowledge retention benefits of flipped classroom learning and to refine the data around how it's applicability can and should be justified given the time and effort required by both educators and students.

CRedit authorship contribution statement

Jessica Phillips: Conceptualization, Methodology, Validation, Investigation, Resources, Writing – original draft, Writing – review & editing, Visualization, Supervision, Project administration. **Franz Wiesbauer:** Conceptualization, Methodology, Validation, Writing – review & editing, Visualization, Supervision, Project administration.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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