ORIGINAL ARTICLE

## Assessment of Factors Affecting Successful Implementation of Flipped Classroom in Medical Education

Lida Jarahi[1], Alireza Ebrahimi[2,*], Mostafa Rashki[3], Alireza Ghodsi[4]
[1]Department of Community Medicine, Faculty of Medicine, Mashhad University of Medical Sciences, Mashhad, Iran
[2]Mashhad Ferdowsi University, Faculty of Educational Sciences and Psychology, Mashhad, Iran
[3]Faculty of Medicine, Zabol University of Medical Sciences, Zabol, Iran
[4]Faculty of Medicine, Mashhad University of Medical Sciences, Mashhad, Iran
[*]Mashhad Ferdowsi University, Faculty of Educational Sciences and Psychology, Mashhad, IRAN
Tel: +918958207039
Email: Ebrahimia4@mums.ac.ir

**Background:** The flipped classroom model (FCM) emphasizes a learner-centered approach that promotes active learning, enhances student engagement, and fosters meaningful educational experiences. This study aimed to evaluate the implementation of the FCM and identify essential conditions for its adoption in medical education.
**Method:** The prerequisites for implementing the flipped classroom were identified through a literature review and expert consultation, and an assessment tool was developed and validated. Two questionnaires and one checklist were used to assess student preparedness, teacher readiness, and technological infrastructure, respectively. The assessment items covered access and skills, motivation and participation, flexibility of instruction and content design, and software and hardware resources, and were scored using a five-point Likert scale. The survey included 250 medical students, 60 medical teachers, and 7 educational technology specialists from Mashhad Medical School.
**Results:** Three main domains of readiness for implementing the flipped classroom were identified: student preparedness, faculty preparation, and technological infrastructure. The mean scores for student preparedness, faculty preparation, and technology provision were 2.82±0.49 (70.5%), 3.56±0.16 (91%), and 3.00±0.58 (75%), respectively, all indicating a desirable level. Motivation (86%) and access to technology (82%) received the highest scores, whereas online skills (54%) and participation in online discussions (58%) received the lowest. Attention to individual learning and professional coaching had the highest faculty scores (90%). Software facilities (89%) were desirable, while hardware facilities (60.7%) were relatively desirable.
**Conclusion:** Successful implementation of the FCM in medical education depends on comprehensive readiness among both educators and students, along with reliable technological support. Addressing these prerequisites is essential to fully realize the benefits of this innovative teaching approach.
**Keywords:** Flipped Classroom, Backward Class, Reverse Teaching, Medical Students, Medical Teachers

## تقييم العوامل المؤثرة في نجاح تطبيق نموذج "الفصل الدراسي المعكوس" في التعليم الطبي

**الخلفية:** يركز نموذج "الفصل الدراسي المعكوس" (FCM) على نهج يتمحور حول المتعلم، مما يعزز التعلم النشط ومشاركة الطلاب ويوفر تجارب تعليمية هادفة. هدفت هذه الدراسة إلى تقييم تطبيق هذا النموذج وتحديد الشروط الأساسية لاعتماده في مجال التعليم الطبي.
**الطريقة:** تم تحديد المتطلبات الأساسية لتطبيق الفصل الدراسي المعكوس من خلال مراجعة الأدبيات واستشارة الخبراء، كما تم تطوير أداة للتقييم والتحقق من صلاحيتها. استُخدمت استبانتان وقائمة تحقق لتقييم مدى جاهزية الطلاب، واستعداد أعضاء هيئة التدريس، والبنية التحتية التكنولوجية، على التوالي. شملت بنود التقييم: إمكانية الوصول والمهارات، والدافعية والمشاركة، ومرونة التدريس وتصميم المحتوى، والموارد البرمجية والمادية (الأجهزة)، حيث تم احتساب الدرجات باستخدام مقياس "ليكرت" الخماسي. شمل الاستطلاع ٢٥٠ طالباً في كلية الطب، و٦٠ عضواً من هيئة التدريس، و٧ متخصصين في تكنولوجيا التعليم من كلية الطب في مشهد.
**النتائج:** تم تحديد ثلاثة مجالات رئيسية لجاهزية تطبيق الفصل الدراسي المعكوس، وهي: جاهزية الطلاب، واستعداد أعضاء هيئة التدريس، والبنية التحتية التكنولوجية. بلغ متوسط درجات جاهزية الطلاب، واستعداد أعضاء هيئة التدريس، وتوفر التكنولوجيا: ٢٫٨٢±٠٫٤٩ (٧٠٫٥٪)، و٣٫٥٦±٠٫١٦ (٩١٪)، و٣٫٠٠±٠٫٥٨ (٧٥٪) على التوالي، مما يشير في جميع الحالات إلى مستوى جيد ومقبول. سجل كل من الدافعية (٨٦٪) وإمكانية الوصول إلى التكنولوجيا (٨٢٪) أعلى الدرجات، في حين سجلت المهارات المتعلقة بالتعلم عبر الإنترنت (٥٤٪) والمشاركة في المناقشات الإلكترونية (٥٨٪) أدنى الدرجات. وحصل كل من الاهتمام بالتعلم الفردي والتوجيه المهني على أعلى درجات التقييم لدى أعضاء هيئة التدريس (٩٠٪). كما كانت الموارد البرمجية (٨٩٪) عند مستوى جيد، بينما كانت الموارد المادية/الأجهزة (٦٠٫٧٪) عند مستوى مقبول نسبياً.
**الخلاصة:** يعتمد نجاح تطبيق نموذج الفصل الدراسي المعكوس في التعليم الطبي على جاهزية شاملة لدى كل من المعلمين والطلاب، إلى جانب توفر دعم تكنولوجي موثوق. وتُعد معالجة هذه المتطلبات أمراً جوهرياً لتحقيق الاستفادة الكاملة من هذا النهج التعليمي المبتكر.
**الكلمات المفتاحية:** الفصل الدراسي المعكوس، الفصل العكسي، التدريس العكسي، طلاب الطب، معلمو الطب

## ارزیابی عوامل مؤثر بر موفقیت اجرای کلاس معکوس در آموزش پزشکی

**زمینه و هدف:** الگوی کلاس معکوس بر رویکردی فراگیرمحور تأکید دارد که یادگیری فعال را ترویج می‌دهد مشارکت دانشجویان را افزایش می‌دهد و تجارب آموزشی معناداری را فراهم می‌کند. این مطالعه با هدف ارزیابی اجرای کلاس معکوس و شناسایی شرایط اساسی برای پذیرش آن در آموزش پزشکی انجام شد.
**روش:** پیش‌نیازهای اجرای کلاس معکوس با بررسی متون و نظر متخصصان شناسایی و ابزار ارزیابی آن طراحی و اعتبارسنجی شد. دو پرسشنامه و یک چک لیست، آمادگی دانشجویان و اساتید و دسترسی به فناوری را ارزیابی کردند. موارد شامل دسترسی/مهارت‌ها، انگیزه و مشارکت، آموزش انعطاف‌پذیر و طراحی محتوا و منابع نرم‌افزاری/سخت‌افزاری بودند که در مقیاس لیکرت پنج درجه‌ای امتیازدهی شدند. در این نظرسنجی ۲۵۰ دانشجوی پزشکی، ۶۰ استاد پزشکی و ۷ متخصص فناوری آموزشی از دانشکده پزشکی مشهد شرکت کردند.
**یافته‌ها:** سه حوزه اصلی آمادگی برای اجرای کلاس معکوس شامل آمادگی دانشجویان، آمادگی اساتید و زیرساخت‌های فناوری شناسایی شد. میانگین نمره آمادگی دانشجویان ۰.۴۹±۲.۸۲(۷۰.۵٪)، آمادگی اساتید ۰.۱۶±۳.۵۶(۹۱٪) و وضعیت فناوری ۰.۵۸±۳.۰۰(۷۵٪) بود که همگی مطلوب ارزیابی شدند. انگیزه (۸۶٪) و دسترسی به فناوری (۸۲٪) بالاترین، و مهارت‌های آنلاین (۵۴٪) و مشارکت در بحث‌های آنلاین (۵۸٪) پایین‌ترین امتیاز را داشتند. در حوزه اساتید توجه به یادگیری فردی و مربی‌گری حرفه‌ای بالاترین امتیاز (۹۰٪) را کسب کردند. نرم‌افزارها (۸۹٪) مطلوب و امکانات سخت‌افزاری (۶۰.۷٪) نسبتاً مطلوب ارزیابی شدند.
**نتیجه گیری:** موفقیت در اجرای الگوی کلاس معکوس در آموزش پزشکی نیازمند آمادگی همه‌جانبه از سوی اساتید و دانشجویان، همراه با پشتیبانی فناورانه مناسب است. پرداختن به این پیش‌نیازها برای بهره‌گیری کامل از مزایای این روش نوین آموزشی ضروری است.
**واژه های کلیدی:** کلاس معکوس، آموزش وارونه تدریس معکوس، دانشجویان پزشکی، اساتید پزشکی

## طبی تعلیم میں 'فلپڈ کلاس روم' (Flipped Classroom) کے کامیاب نفاذ پر اثر انداز ہونے والے عوامل کا جائزہ

**پس منظر:** فلپڈ کلاس روم ماڈل' (FCM) سیکھنے والے پر مرکوز (learner-centered) اُس نقطہ نظر پر زور دیتا ہے جو فعال اندازِ تعلیم (active learning) کو فروغ دیتا ہے، طلبہ کی شمولیت میں اضافہ کرتا ہے اور بامقصد تعلیمی تجربات کی راہ ہموار کرتا ہے۔ اس تحقیق کا مقصد FCM کے نفاذ کا جائزہ لینا اور طبی تعلیم میں اسے اپنانے کے لیے ضروری شرائط کی نشاندہی کرنا تھا۔
**طریقہ:** لٹریچر کے جائزے اور ماہرین کی مشاورت کے ذریعے فلپڈ کلاس روم کے نفاذ کے لیے درکار بنیادی تقاضوں کی نشاندہی کی گئی، اور ایک تشخیصی ٹول (assessment tool) تیار کر کے اس کی توثیق کی گئی۔ طلبہ کی تیاری، اساتذہ کی تیاری اور تکنیکی بنیادی ڈھانچے کا جائزہ لینے کے لیے بالترتیب دو سوالنامے اور ایک چیک لسٹ استعمال کی گئی۔ تشخیصی نکات میں رسائی اور مہارتیں، ترغیب اور شرکت، تدریس اور مواد کی تشکیل میں لچک، اور سافٹ ویئر و ہارڈ ویئر کے وسائل شامل تھے، اور ان کی درجہ بندی کے لیے 'فائیو پوائنٹ لیکرٹ اسکیل' (five-point Likert scale) کا استعمال کیا گیا۔ سروے میں مشہد میڈیکل اسکول کے ۲۵۰ طبی طلبہ، ۶۰ طبی اساتذہ اور تعلیمی ٹیکنالوجی کے ۷ ماہرین شامل تھے۔
**نتائج:** فلپڈ کلاس روم کے نفاذ کے لیے تیاری کے تین اہم شعبوں کی نشاندہی کی گئی: طلبہ کی تیاری، فیکلٹی (اساتذہ) کی تیاری، اور تکنیکی بنیادی ڈھانچہ۔ طلبہ کی تیاری، فیکلٹی کی تیاری اور ٹیکنالوجی کی فراہمی کے لیے اوسط اسکور بالترتیب ۲٫۸۲ ± ۰٫۴۹ (۷۰٫۵ فیصد)، ۳٫۵۶ ± ۰٫۱۶ (۹۱ فیصد) اور ۳٫۰۰ ± ۰٫۵۸ (۷۵ فیصد) رہے، جو سب ایک مطلوبہ سطح کی نشاندہی کرتے ہیں۔ ترغیب (۸۶ فیصد) اور ٹیکنالوجی تک رسائی (۸۲ فیصد) نے سب سے زیادہ اسکور حاصل کیے، جبکہ آن لائن مہارتوں (۵۴ فیصد) اور آن لائن مباحثوں میں شرکت (۵۸ فیصد) نے سب سے کم اسکور حاصل کیے۔ انفرادی سیکھنے کے عمل پر توجہ اور پیشہ ورانہ رہنمائی (coaching) کے شعبے میں فیکلٹی کا اسکور سب سے زیادہ (۹۰ فیصد) رہا۔ سافٹ ویئر کی سہولیات (۸۹ فیصد) مطلوبہ معیار کے مطابق تھیں، جبکہ ہارڈ ویئر کی سہولیات (۶۰٫۷ فیصد) نسبتاً مطلوبہ سطح پر تھیں۔
**نتیجہ:** طبی تعلیم میں FCM کا کامیاب نفاذ اساتذہ اور طلبہ دونوں کی مکمل تیاری اور قابلِ اعتماد تکنیکی معاونت پر منحصر ہے۔ تدریس کے اس جدید انداز کے فوائد سے مکمل طور پر مستفید ہونے کے لیے ان بنیادی تقاضوں کو پورا کرنا ناگزیر ہے۔
**کلیدی الفاظ:** فلپڈ کلاس روم، بیک ورڈ کلاس (Backward Class)، ریورس ٹیچنگ (Reverse Teaching)، طبی طلبہ، طبی اساتذہ

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## INTRODUCTION

The flipped educational model is a learner-centered approach that emphasizes practical application, in which students review educational content before class and participate in collaborative activities during class time (1, 2). Various terms associated with the flipped classroom model (FCM), including flip teaching, backward class, reverse teaching, substitute class, reverse instruction, and blended learning, highlight the significance of active student involvement and participation in the educational process (3, 4). In the FCM, students receive educational resources, often in the form of video lessons created by teachers or selected documents, before attending class. They then engage in various class activities, which are typically regarded as homework, such as participating in discussions, solving problems, or conducting research (1-3). Teachers serve as consultants and facilitators, while students engage in independent learning of new educational content and apply their knowledge to practical tasks during class sessions. This includes participating in discussions and analyzing different aspects and complex issues related to the subject, which fosters a sense of responsibility for their education and involvement in the learning process (4). The flipped educational model has been adopted by numerous medical universities worldwide and has received positive feedback from both students and educators (5-7). The FCM is a cost-effective strategy that not only enhances the learning experience for medical students but also enables them to engage in active learning, critical thinking, and problem-solving, resulting in a deeper understanding of the subject matter (7-9).

Despite the clear advantages of the FCM, students may encounter obstacles such as low motivation, insufficient academic and cognitive responsibility, reluctance or inability to learn independently, and time constraints that impede their capacity to engage in self-directed learning and work (9). Additionally, teachers' ability to provide high-quality materials for self-learning is crucial (10, 11).

Numerous studies have demonstrated the effectiveness of the Flipped Classroom Model (FCM) and students' positive attitudes toward this approach; however, discussion remains regarding the evaluation of its implementation and requirements for medical students (1, 2, 12). The objective of this study was to assess the implementation and requirements of the FCM for medical students, identify its strengths and weaknesses, and offer recommendations for its effective implementation.

## METHODS

Evaluating the requirements for the flipped classroom

The initial step in determining the prerequisites for implementing the FCM involved a review of the existing evidence and discussions with an expert panel. Six faculty members from Mashhad Medical School, recognized as experts in medical education, were invited to take part in this evaluation. The result of this process was a chart depicting the feasibility and requirements for implementing the flipped approach. This chart outlines the prerequisites of the FCM across three areas: students' readiness, teachers' preparation, and technological resources (Figure 1). Potential prerequisites for the implementation of the Flipped Classroom Model (FCM) were identified through a literature review and discussions with an expert panel. The prerequisites of the FCM were examined in three areas: students' readiness, teachers' preparation, and technological resources. A tool for the implementation of the FCM (comprising two questionnaires and one checklist) was developed and, after validation, was used to evaluate the status of FCM implementation at Mashhad Medical School, involving 250 medical students, 60 medical teachers, and 7 educational technology specialists who participated in the study.

*Questionnaire Design*

To evaluate student preparedness, teacher readiness, and technology availability, two questionnaires and one checklist were created. The student questionnaire assessed access to technology, computer proficiency, online skills, motivation, comprehension of online audio and video, ability to engage in online discussions, and attitudes toward achieving success. Conversely, the teacher preparation questionnaire focused on their ability to foster a flexible learning environment, cater to individual learning needs, develop engaging content, and provide professional coaching. The technology checklist was categorized into two areas: software and hardware resources, each containing multiple subdomains. Scoring utilized a five-point Likert scale, ranging from total agreement to total disagreement.

*Validity and reliability*

The validity of the final questionnaires was established through feedback from a panel of medical experts. Reliability was assessed using Cronbach's alpha coefficient, which yielded values of 0.92 for the students' preparedness questionnaire and 0.89 for the teachers' preparation questionnaire.

Data collection

In the subsequent phase of the study, the validated and reliable questionnaires were used to collect data from pre-clinical medical students and their instructors. Furthermore, the technology checklist was completed by seven information technology specialists from Mashhad Medical School in Iran.

*Statistical analysis*

The Likert scores ranged from 0 to 4, with a score

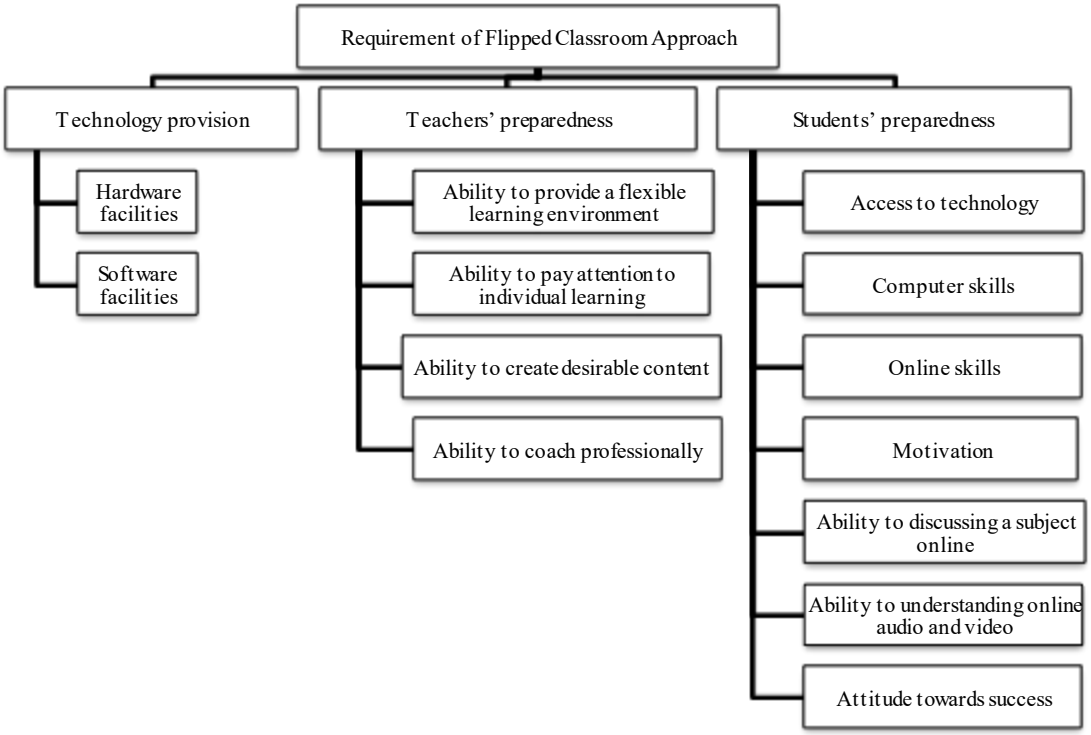


**Figure 1. Requirements for implementation of the flipped classroom model in three domains related to students, teachers, and technology**

of 4 indicating complete agreement and a score of 0 indicating complete disagreement. Mean scores and standard deviations (SD) were calculated, and the results were categorized based on these scores. A score between 0 and 1.33 was deemed undesirable, 1.34 to 2.66 was considered relatively desirable, and 2.67 to 4 was classified as desirable.

## RESULTS

Three key areas were identified as potential prerequisites for implementing the flipped classroom model (FCM): students' readiness, teachers' readiness, and technological resources. When evaluating students' readiness, factors such as access to technology, computer skills, online skills, motivation, ability to comprehend online audio and video, ability to engage in online discussions, and attitude toward success were considered. Teachers' readiness was evaluated based on their ability to create a flexible learning environment, cater to individual learning needs, produce engaging content, and provide professional coaching. The assessment of technological resources focused on both hardware and software facilities.

An assessment of FCM implementation at Mashhad Medical School, using specific tools, revealed mean scores of 2.82 ± 0.49 for students' readiness, 3.56 ± 0.16 for teachers' readiness, and 3.0 ± 0.58 for technological resources. Among students, online skills and the ability to engage in online discussions received lower scores in the readiness domain (2.16 ± 0.85 and 2.32 ± 0.84, respectively), while access to technology and attitude toward success received higher scores (3.31 ± 0.27 and 3.10 ± 0.88, respectively).

In terms of teachers' readiness, the highest scores were observed for their ability to cater to individual learning needs, provide professional coaching, and create engaging content (3.62 ± 0.33, 3.61 ± 0.26, and 3.57 ± 0.31, respectively), while the ability to create a flexible learning environment received the lowest score (3.45 ± 0.29). In the technology resources domain, hardware facilities scored lower than software facilities (3.57 ± 0.53 vs. 3.0 ± 0.58). Table 1 shows the basic information of the study participants. Details of the scores for medical students' readiness, teachers' readiness, and technological resources for the flipped classroom model are provided in Table 2.

## DISCUSSION

This research emphasizes the importance of a thorough approach to implementing FCM that addresses the necessary requirements in areas such as students' readiness, teachers' preparedness, and

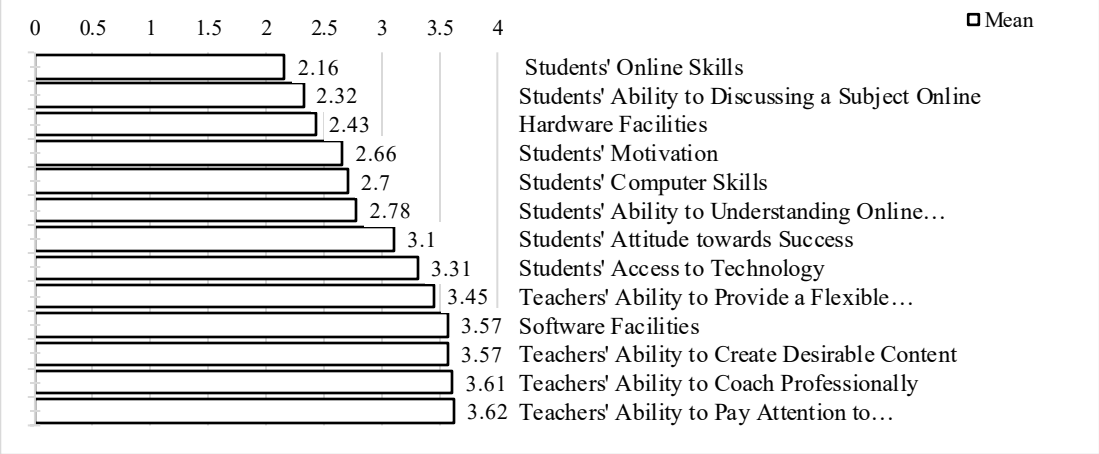


**Figure 2. Comparison of the mean scores of medical students' preparedness, teachers' preparation, and technology provision**

**Table 1. Basic information of the study participants**

| Participants | | Number | Years of employment/study Mean (SD) | Age Mean (SD) |
|---|---|---|---|---|
| Medical teachers | Assistant Professor | 12 | 7.5 (3) | 46 (8) |
| | Associate Professor | 38 | 15 (5) | 48 (10) |
| | Professor | 10 | 21 (7) | 52 (11) |
| Medical students | | 250 | 2.5 (1) | 22 (3) |
| Information technology experts | | 7 | 8.2 (4) | 32 (5) |

technological resources.

Compared with traditional lectures, the flipped classroom model has been beneficial in providing psychological and pedagogical support to learners, identifying students' learning challenges, and receiving positive feedback from both teachers and students (12). The flipped classroom represents a significant shift from traditional print-based teaching methods, bringing about changes in the roles of teachers and curriculum models. Educators and students are increasingly becoming interested in this new approach to teaching. Different countries, including Australia, China, Germany, Spain, and the United States, are at the forefront of developing the flipped classroom concept. As technology continues to advance, educators will continue to explore the effectiveness of flipped classrooms compared with traditional teaching methods (13).

An essential factor for the successful implementation of the flipped classroom method is ensuring that students are adequately prepared for in-class activities and discussions to facilitate learning (14, 15).

However, this study revealed that medical students struggled with online discussions, a crucial aspect of FCM, and performed poorly in terms of their online skills, which are essential for information sharing in flipped classrooms.

Enhancing medical students' proficiency in using online resources such as web lectures, texts, scientific papers, and formative assessments is critical for the effective implementation of FCM (13, 15). While teachers at Mashhad Medical School were generally regarded as proficient, their ability to create a flexible learning environment received lower ratings in terms of teacher preparation.

To enhance motivation and engagement in flipped classrooms, it is crucial to establish a flexible and engaging learning environment, offer professional guidance to students, and conduct student assessments through dynamic and flexible evaluations that assess skills such as creativity and collaboration, including group discussions, problem-solving, and small project creation (9, 15, 16). Faculty training on how to develop and implement FCM using a student-centered approach, as well as utilizing appropriate platforms, frameworks, and teaching strategies, is crucial for the successful implementation of FCM (17).

Apart from human factors, building a stable and

**Table 2. Scoring of medical students' preparedness, teachers' preparation, and technology provision for the flipped classroom model**

| Domains | Features | Score Mean (SD) | Relative Percent (%) | Status |
|---|---|---|---|---|
| Medical Students' Preparedness | Access to technology | 3.31 (0.27) | 82 | Desirable |
| | Computer skills | 2.70 (0.97) | 67 | Desirable |
| | Online skills | 2.16 (0.85) | 54 | Relatively desirable |
| | Motivation | 3.45 (0.29) | 86 | Desirable |
| | Ability to understanding online audio and video | 2.78 (1.03) | 69.5 | Desirable |
| | Ability to discussing a subject online | 2.32 (0.84) | 58 | Relatively desirable |
| | Attitude towards success | 3.10 (0.88) | 77 | Desirable |
| | Total students' preparedness for flipping | 2.82 (0.49) | 70.5 | Desirable |
| Medical Teachers' Preparation | Ability to provide a flexible learning environment | 3.45 (0.29) | 86 | Desirable |
| | Ability to pay attention to individual learning | 3.62 (0.33) | 90 | Desirable |
| | Ability to create desirable content | 3.57 (0.31) | 89 | Desirable |
| | Ability to coach professionally | 3.61 (0.26) | 90 | Desirable |
| | Total teachers' preparation for flipping | 3.56 (0.16) | 91 | Desirable |
| Technology Provision | Hardware facilities | 2.43 (1.13) | 60.7 | Relatively desirable |
| | Software facilities | 3.57 (0.53) | 89 | Desirable |
| | Total technology status | 3.0 (0.58) | 75 | Desirable |

modern technical infrastructure also plays an important role in the success of FCM. In recent years, advances in educational technology have played a significant role in increasing the use of blended learning approaches (17,18).

Besides human factors, having a strong and up-to-date technical foundation is crucial for the success of FCM. Educational technology advancements have greatly contributed to the rise of blended learning methods in recent times. However, the introduction of the FCM has also posed technical challenges. The main focus has been on the quality of shared videos. Other factors to consider include unequal access to technology, associated costs, the importance of technology proficiency among educators and students, and the necessary infrastructure and institutional support (19-22).

In the context of Mashhad Medical School, assessment of technology provision revealed shortcomings in the hardware section that required enhancement. While access to technology is crucial for FCM's success, it serves as a tool for facilitating students' learning, with their success ultimately dependent on their skills and capabilities. In conclusion, this research highlights the significance of considering the requirements of FCM for its successful integration into medical education. It implies that both students and instructors should be ready and provided with the essential skills and tools to efficiently utilize FCM, as well as sufficient technological resources to support its implementation (23, 24).

This study assessed FCM implementation in Mashhad Medical School by evaluating human resources and infrastructure. However, the findings are limited to an Iranian population of medical students. Further studies should be conducted in other populations and institutions, with a particular focus on medical students, as there is currently insufficient evidence regarding this group.

## CONCLUSION

This research highlights the importance of recognizing the necessary conditions for the successful adoption of FCM in medical education. It indicates that both students and educators must be

adequately prepared and possess the essential skills and resources for effective FCM use, while also having sufficient technological support to facilitate FCM implementation.

**Ethical Considerations:**

Ethical issues including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc. have been completely observed by the authors.

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